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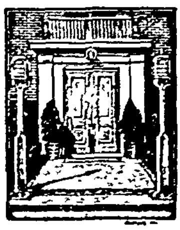
TO STIMULATE THE IMAGINATION, TO PROVIDE THE
INQUIRING MIND WITH ACCURATE
INFORMATION TOLD IN AN INTERESTING
STYLE, AND THUS LEAD INTO
BROADER FIELDS OF KNOWLEDGE,
SUCH IS THE PURPOSE OF
THIS WORK



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COMPTON'S PICTURED ENCYCLOPEDIA

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Here and There in This Volume

At odd times when you are just looking for "something interesting to read," without any special plan in mind, this list will help you. With this as a guide, you may visit faraway countries, watch people at their work and play, meet famous persons of ancient and modern times, review history's most brilliant incidents, explore the marvels of nature and science, play games—in short, find whatever suits your fancy of the moment. This list is not intended to serve as a table of contents, an index, or a study guide. For these purposes consult the Fact-Index and the Reference-Outlines.

Pictures You Will Enjoy

For the Reading Hour

Parent and Child; School and Home

High Lights in History's Pageant

Some Famous Men and Women

Travel Views at Home and Abroad

In the Plant and Animal World

Marvels of Science and Invention

The World at Work

Guideposts to Literature, Art, and Music

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KEY TO PRONUNCIATION

Pronunciations have been indicated in the body of this work only for words which present special difficulties. For the pronunciation of other words, consult the Fact-Index. Marked letters are sounded as in the following words: cāpe, ăt, fär, fȧst, whạt, fạll; mē, yĕt, fẽrn, thêre; īce, bĭt; rōw, wôn, fôr, nŏt, do̤; cūre, bŭt, ru̇de, fu̧ll, bûrn; *out*; ü=French *u*, German *ü*; ġem, ḡo; *th*in, *th*en; ṅ=French nasal (Jeaṅ); *zh*= French *j* (*z* in azure); κ=German guttural *ch*.

P

The PACIFIC *and* *Its* MYRIAD ISLANDS

PACIFIC OCEAN. Before the second World War, most people thought about the vast Pacific as a far away, and romantic part of the earth. They saw in their mind's eye palm trees swaying over dreamy islands, black volcano cones rising amid the dense green of the rain forests, blue waters lapping coral beaches, bronzed native boys spearing bright fish in quiet lagoons. For many people, the South Seas were a kind of "never-never" land—a setting for imaginative tales which carried their readers away from the reality of everyday life. In their musings they never dwelt on the possibility of war's coming to these vast and peaceful waters.

But in December 1941, war spread over great stretches of the Pacific Ocean, and the bright flames of conflict focused the world's attention as never before on this greatest of oceans. As the names of one island after another appeared in newspaper stories and radio broadcasts, people began to see the little dots of land, not as sleepy isles of "escape," but as naval and air bases of such strategic importance that thousands of American young men—together with those of other nations—were dying in the fight for their possession. And the waters of the Pacific had become naval battlefields.

Even before the war, airplanes had spanned the vast reaches of the Pacific. Great passenger liners flew regularly between America and the Far East, using the scattered islands as steppingstones. But the war gave a tremendous new impetus to the development of air transportation. On hundreds of additional islands, landing fields and air bases were built for the use of the bombers, fighters, and transport planes of the United Nations. The vastness of this great ocean has been conquered and the isolation of its far-flung islands has come to an end.

If we want to understand the new rôle of the Pacific in world affairs, we should first know something of its geography, its people, and its history.

"UNDER THE WIDE AND STARRY SKY"

Like the line above from the epitaph of Robert Louis Stevenson, who loved the South Seas, this scene depicts that vast, restful part of the world forever associated with tumbling surf and palm leaves stirring in a soft breeze.

The largest of the world's oceans was named "Pacific" by the explorer Magellan, who found it calm and peaceful after his voyage around South America. But the vast Pacific is not always calm; it too has violent storms as fierce as those of any other ocean. Generally, however, the wind blows less fiercely and more steadily here than it does over the Atlantic.

This giant of waters occupies one-third of the earth's surface. It stretches 9,300 miles from the Arctic Circle at Bering Strait to the South Polar zone; and along the Equator it reaches nearly half-way around the globe. Its area of nearly 64 million square miles is greater than the entire land area of the world, and it contains half of all the water on the earth.

Let us look for a moment at the map of the Pacific. We see that the eastern limits of the ocean are sharply defined by the western coasts of the Americas. Here the boundary is broken only by the long chain of Aleutian Islands off Alaska and the great Mexican peninsula of Lower California.

The western limits of the Pacific, however, are in great contrast to the eastern. From north to south, the western side of the ocean is broken up by numerous peninsulas and islands; and the resulting bays and arms of the Pacific are named as separate seas. To the north are the Bering Sea and the Sea of Okhotsk, the Sea of Japan and the Yellow Sea, the East China Sea and the South China Sea. Further south the large islands of the East Indies break up the ocean into the Celebes Sea, the Java Sea, and the Timor Sea. The continent of Australia marks off the Coral Sea and the Tasman Sea.

In this article we shall set the western limits of the Pacific at Japan, the Philippines, and New Guinea. We select this dividing line because the island groups near the mainland of Asia (as well as New Zealand off the coast of Australia) are classified as coastal archipelagoes rather than Pacific Islands. The story

of their geography and peoples—and the story of Australia—is told in separate articles (*see* Australia; East Indies; New Zealand).

Why the Pacific Is So Blue

The Pacific is the deepest of oceans. Its average depth is more than two and one half miles. Its greatest depth is 35,640 feet, the Challenger Depth, in Mansyu Deep off the northeast coast of Mindanao in the Philippines. If Mount Everest, the world's tallest mountain, were set down in this chasm, its summit would be 6,612 feet below the surface of the sea. The Pacific is bluer than the Atlantic, because the surface color of the Atlantic is screened by greater masses of the microscopic plant and animal life called plankton. The Pacific has a lower proportion of nitrogen compounds from decaying matter which support plankton.

Enchantment of the South Seas

The mighty Pacific washes the shores of four continents —North and South America, Asia, and Australia—and its waters mingle in the southeast with the Atlantic Ocean and in the southwest with the Indian Ocean. But it is not on the shores of the continents or in the coastal islands that we find the soul of the great Pacific. It lies far out where those fabled "South Sea Isles" are scattered over the vast expanse like stars in the sky. Here, in mid-ocean, monster disturbances at the heart of the earth have thrust great mountains and volcanoes above the water, and tiny coral creatures with ceaseless labor have crowned the ocean with thousands of ring-shaped islands called atolls. The air that sweeps these islands is fragrant with flowers and spice. Bright warm days and clear cool nights follow one another in eternal procession, while the rolling swells break in never-ending roar on the dazzling shores, and overhead the slender coconut palms whisper their soft, drowsy song.

When white men first came to the Pacific islands, they found the inhabitants like happy children who had never grown up. Tall magnificent men and handsome women they were for the most part, and apparently they had not a care in the world. Coconut palms and breadfruit trees grew at the doors of their huts. The surrounding waters were filled with turtles and fish, ready for the net. For clothing they had little need. Disease was virtually unknown.

Occasionally cruel and bloody wars broke out between neighboring tribes, or swift canoe raids were made on near-by islands; but the brown warriors were athletic and brave, and found fun in fighting. It is true that many of them were cannibals, who cooked and ate the enemies they killed—this was part of their island law and religion. But at most times these savages were friendly, courteous, and hospitable. All these things the first explorers found and wondered at, and some were so fascinated that they forgot their homes and settled down to live among the natives for the remainder of their days.

WHO MADE THIS GROTESQUE FIGURE?

The origin of this and other stone images like it on Easter Island is a secret not yet revealed to us. The men and horses emphasize the statue's great bulk.

The Blight of the White Man

Today, however, the bloom of the Pacific is gone, like a delicate flower that drooped and faded at the white man's touch. The jeweled islands are still there, but the peoples who used to live in such carefree happiness are rapidly vanishing. On islands where thousands lived a hundred years ago, only a few score are left. Diseases—tuberculosis, smallpox, leprosy, and many others—were left in the wake of the great sailing vessels and in the trail of the steamers' smoke. The islanders, from time immemorial free from the attack of disease, had slight power to resist infection. They fell, and continue to fall, easy victims to the scourges of civilization. Even measles, which we count a minor ailment, killed them by the thousands.

Such was the tragedy of the Pacific. In another hundred years there will be left scarcely a single pure-blooded member of what was once called "the noblest of all primitive races."

Unsolved Mystery of the Pacific

The story of the Pacific confronts us at the outset with one of the mysteries of archaeology. Scattered through the island groups from one side of the ocean to the other are found the remains of an ancient race

of skilled builders. Ruins have been discovered of huge altars, tombs, and dwellings built of great blocks of stone carefully fitted together without mortar. Traces exist in some places of houses built out over the sea, of canals, and of gigantic piers and breakwaters. On tiny Easter Island —which is 2,500 miles from the coast of Chile in South America and 1,400 miles from any other inhabited island— are found great walls and platforms 30 feet high, surmounted by pedestals. Upon these once stood the colossal statues which now lie near by, the largest of which is 37 feet high. Though crumbling with age, these statues still show resemblance to the human form. In a quarry on the other side of the island is a figure half cut out from the volcanic rock which measures 70 feet. On some of the stones are traced geometrical patterns and the shapes of animals.

Who were these builders, whence did they come, and whither did they go? The natives who lived on these islands when the first white men arrived knew no more about the puzzle than we do today.

VARIED TYPES OF PEOPLE WHO LIVE ON THE FAR-FLUNG ISLANDS OF THE PACIFIC

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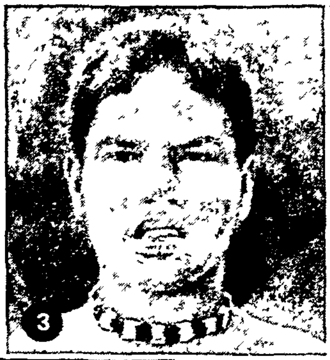

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1. Pribilof islander, with Mongol features, who dwells in the far northeast. **2.** Attractive Hawaiian girl with straight hair and white skin. **3.** Micronesian of the Gilbert Islands. **4.** Handsome, stalwart, brown-skinned Samoan warrior. **5.** Dark, fuzzy-haired, semi-Melanesian of the Fiji Islands. **6.** Melanesian chieftain of the New Hebrides, true Negroid type.

Island Groups in the Pacific

The Pacific islands, often called by the general name of "Oceania," form a kind of "Milky Way" some 8,000 miles long, which stretches from the Philippines and New Guinea to distant Easter Island. They fall into three great divisions, according to their position and the character of their native population. And these divisions in turn are divided up into smaller clusters, each with its own name.

From the coastal islands of Asia, two separate branches of Pacific islands emerge. The southern chain, which lies entirely below the Equator, forms a crescent. This division is known as *Melanesia* ("islands of the blacks"). It begins east of New Guinea with the Admiralty Islands and the larger individual islands of New Ireland and New Britain. Then the chain swings to the southeast through the Solomon Islands and the Santa Cruz Islands, the New Hebrides Islands, and the Loyalty Islands. East of the New Hebrides lies the Fiji group.

The northern chain is called *Micronesia* ("small islands"). It stretches eastward from the Philippines through the Palau Islands, the Marianas Islands and Guam, the Caroline Islands, and the Marshall Islands. Then the chain dips southeast through the Gilbert Islands (on the Equator) and the Ellice Islands, forming a crescent much larger than that of Melanesia.

The eastern ends of these two crescents meet and then open out into the far-flung scattered islands known as *Polynesia* ("many islands"). Beginning east of the Fiji Islands we find the Tonga (or Friendly) Islands and the Samoa group. Farther east we come to the Cook Islands and the Society Islands (which include romantic Tahiti); then the Tuamotu Archipelago and the Marquesas Islands. And far to the north of the Equator lie the Hawaiian Islands.

These three large divisions are inhabited by three distinct peoples with different racial origins and different cultures. How these diverse peoples arrived at the islands on which we find them today is a matter more of conjecture than of exact knowledge. It is quite generally believed, however, that all these islands were settled by people from Asia, who passed down the Malay Peninsula and out into the islands beyond in waves that became successively more widespread. The Melanesian Islands, which lie close to the Malay Peninsula, were probably settled first, and the islands of Micronesia and Polynesia were inhabited later.

It is a remarkable fact that, although the Melanesians settled on islands close to the mainland of Asia, they are

the most primitive people in the Pacific. In contrast to them, the Polynesians—who had to go farther in search of their homes—are in many respects the most nearly civilized according to our own standards.

Let us look at the three types of islanders, see how they live, and wherein they differ from one another. We shall begin with those who have lived for the longest period of time in the Pacific.

The Natives of Melanesia, the "Black Islands"

The natives of Melanesia, like those of New Guinea, have very dark skin, thick lips, broad, flat noses, protruding faces, and kinky, fuzzy hair. They are frequently referred to as "Oceanic Negroids" because they resemble the African Negroes. In general, Melanesians are shorter than other Pacific islanders; in fact, some of the tribes in the interior of New Guinea and on the New Hebrides are pigmies. In the western end of Melanesia one sees strong traces of Papuan and Malay blood in the natives; while to the east, notably in the Fijis, the Melanesians are mixed with the Polynesians.

Melanesians are not such accomplished sailors and fishermen as the other Pacific islanders, but they are better farmers. Small fields and gardens are their chief source of food. They raise the starchy taro plant, sweet potatoes and yams, bananas, squashes, and pumpkins. Domestic pigs and the small game from the dense forests supply them with meat.

Although their social and political customs are crude, the Melanesians show marked skill in wood carving and other decorative arts. In former times they were feared by neighboring islanders and explorers alike because of their cannibalism—which was associated with their religious and warlike rituals. Cannibalism has become practically extinct in recent years, but the Melanesians remain the least civilized of the Pacific islanders. At the same time, they are the most energetic and industrious.

Micronesia, the "Small Islands"

The people of Micronesia are somewhat mixed. Those of the western islands—toward Asia—resemble the Malays or the Filipinos, small in stature with coppery brown skins. These include the natives of the Palau Islands, the Marianas, and the western Carolines. The Malay influence is apparent in their customs. The chewing of betel nut—a habit common in southwestern Asia—prevails here, but is unknown farther eastward. The people of eastern Micronesia, including the eastern Carolines, the Marshalls, the Gilberts, and the Ellice group, are more nearly like the neighboring Polynesians in appearance and culture.

In contrast both to Melanesia and Polynesia, these small islands have meager resources. There is little soil on the coral foundations of the islands, and though the people are less savage than the Melanesians, they lead primitive lives. In Micronesia are found the remains of great stone structures erected by the earliest inhabitants of these islands. Notable among the remnants of that former culture are the ruins of large palaces, extensive burying grounds, and elaborate temples on the island of Ponapé, in the eastern Carolines.

Polynesia—Its People and Culture

The Polynesians—about whom so many romantic tales have been written—are tall, well-built people. The color of their skin ranges from light brown to almost white. Their black hair is straight or wavy, and the women keep theirs carefully groomed and scented with coconut oil. Their lips are full and their noses are thick, but not flat. In general, the men are handsome, stalwart fellows, and the women, even by Caucasian standards, are usually attractive and often beautiful. In short, the physical appearance of these people so closely resembles that of the white man that among other Pacific islanders the Polynesians are distinctive and easily recognized.

Polynesians—or Kanakas, as they are sometimes called—are hospitable, kindly, and intelligent people. In their happy and indolent life they long ago lost the desire to work, as well as much of their skill in manual arts; but their political and social organization was in the past the highest in the Pacific. They are completely at home in the water or upon it. Among them may be found some of the strongest swimmers, most skillful fishermen, and boldest sailors in the world. These qualities were no doubt inherited from their daring ancestors who, in small boats and without charts or compasses, made their way over vast stretches of ocean to these remote islands.

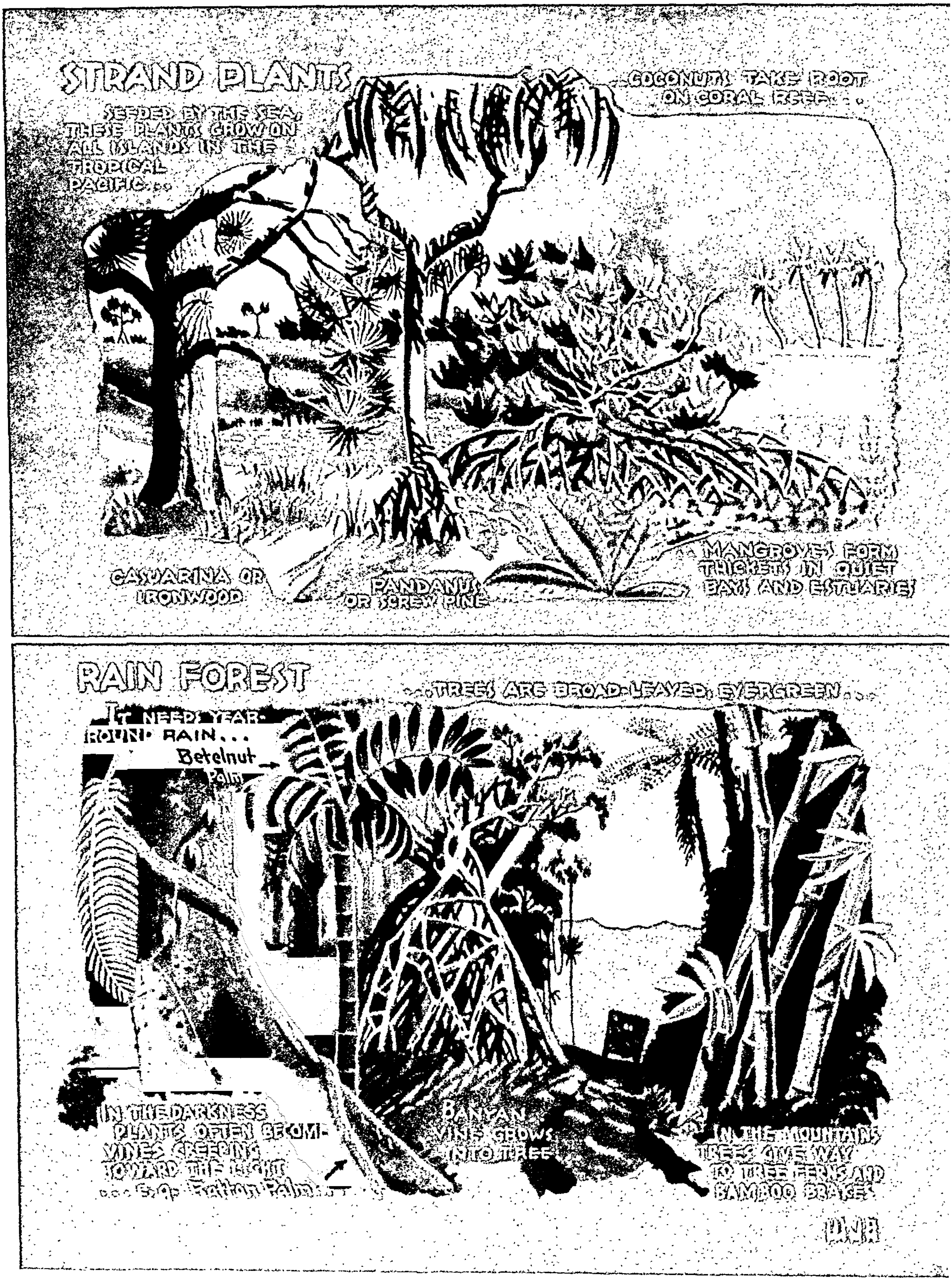
Much of the Polynesian culture of former days has disappeared, largely because of the influence of European and American visitors and settlers. Missionaries brought Christianity to replace many of the ancient rites, and traders brought various manufactured articles as substitutes for the products of traditional native crafts.

Two natural resources, however, continue to be important in the lives of Polynesians—fish and coconuts. Much of the natives' diet comes from the sea. The meat of the coconut serves as food and the milk as a beverage. From the dried coconut meat the natives make copra, their chief marketable product. From the fiber of the husk they make cord, and from the leaves of the tree they weave baskets and mats.

In days past, the Polynesians had a rich oral literature comprising legends, myths, and religious chants. Little of this literature remains today, however, and there are almost no traces of their elaborate social organization. Before Christianity was brought to

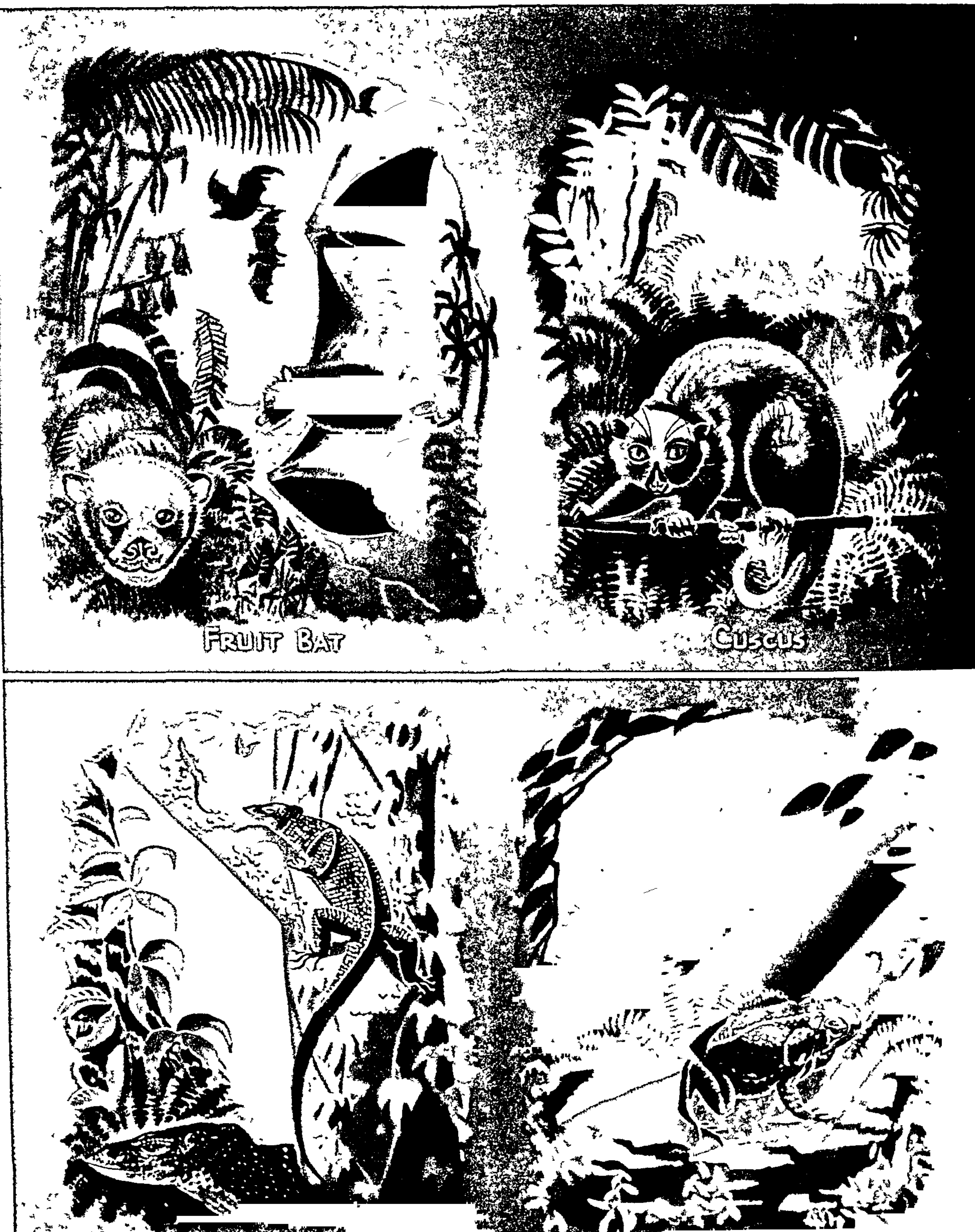
A PAINTER-SCIENTIST IN THE SOUTHWEST PACIFIC

The pictures on the next four pages were painted from life by William J. Beecher, distinguished ecologist, while he was serving with the American forces against the Japanese in the Solomon Islands. With a rare combination of artistic insight and scientific accuracy, he reveals the character of the tropical lands of the Southwest Pacific, with some interesting examples of their plant and animal life and of the forest resources on which the natives live. What these pictures tell is typical of most of this vast region, including the coasts of New Guinea.



SOME CONTRASTS IN PLANT LIFE

Here are shown the two types of vegetation typical of the larger islands of the tropical Pacific—the strand plants and those of the dense rain forests. The seeds of the former often fall into the water and so have been carried from island to island by winds and ocean currents.

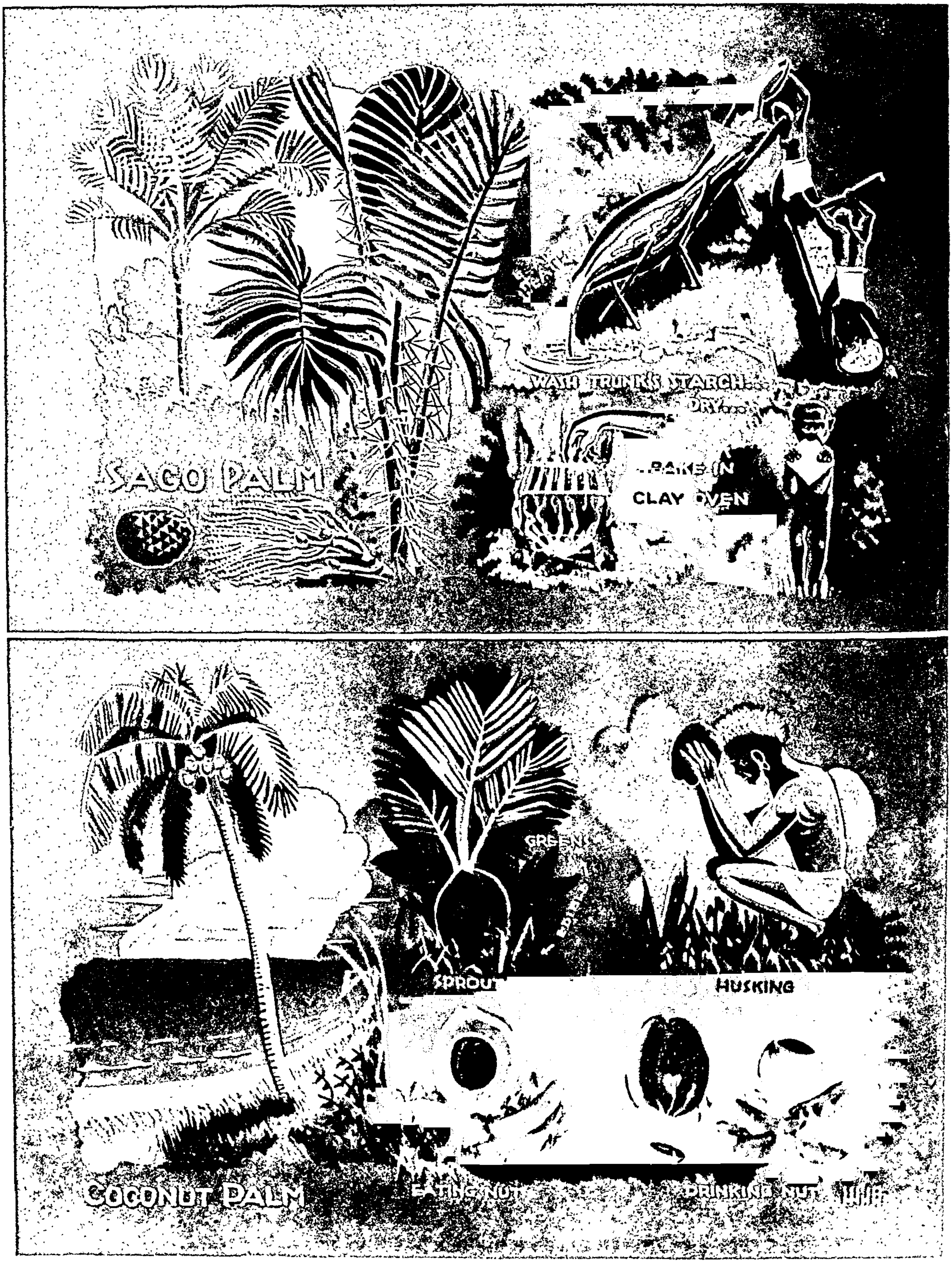


UNUSUAL ANIMALS OF THE RAIN FOREST

The fruit bats are giants of their kind with wingspreads of three feet or more. The cuscus is a marsupial resembling the opossum in habits The monitor is the largest of all lizards, reaching a length of eight feet. Immigrant toads were imported from South America into many of the islands to kill insects and have greatly multiplied.

SOME EDIBLE PLANTS OF THE ISLANDS

The forests of the tropical Pacific islands offer an abundant supply of food to those who can recognize the edible species of plants Here are four of the most important ones Some of the plants produce fruits like the papaya, which can be eaten raw Others have stalks or roots that must be cooked to make them palatable

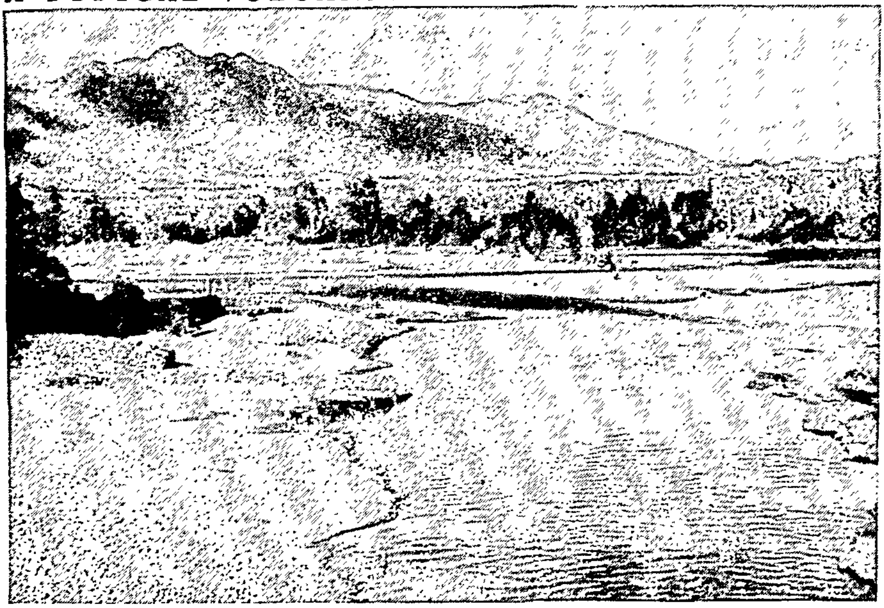


TWO OF THE NATIVE FOOD "INDUSTRIES"

The edible part of the sago palm is the starchy heart of the trunk. The picture at the top shows how this is beaten out, washed, baked, and eaten by Solomon islanders. At the bottom we see three stages in the useful life of a coconut. Young sprouts provide salad; green nuts yield coconut "milk"; and the mature ones offer solid "meat."

them, the religion of the Polynesians was marked by elaborate rituals based upon faith in magic (*see* Magic). The practise of *tabus*, or religious prohibitions, was widespread. Tabus were used in place of laws to protect the persons of chiefs, to shut out the people from certain temples or houses, and for scores of other purposes. To eat tabu food, to lay hands on a tabu person, to enter a tabu dwelling brought upon the offender, according to native belief, grave misfortune or even death.

A TYPICAL VOLCANIC ISLAND OF THE PACIFIC



The rugged mountains suggest the volcanic origin of New Caledonia, pictured here. The range collects the bountiful rainfall that encourages the heavy tropical vegetation.

The Formation and the Climate of the Islands

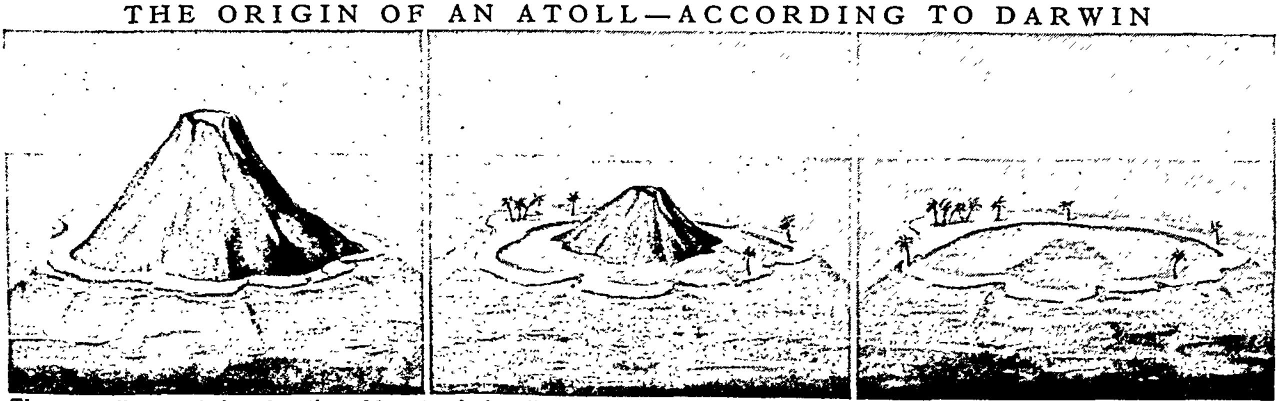
The Pacific islands are either volcanic or coral. Often these two types are combined, coral reefs or barriers having been built up on volcanic foundations.

The type of coral islands called *atolls* is most common in the central Pacific. They are shaped like rings or horseshoes, from one mile to more than a hundred miles in circumference; and they rise only a few feet above the surrounding waters. They are fringed with coconut palms, and here and there in the shallow soil grow pandanus trees, which provide not only fruit, but timber, dye, and leaves for thatching roofs and making hats. Rats and land crabs are the only animals, but the surrounding waters teem with varied fish. The ring of coral reefs usually has one or more openings leading to the lagoon within, which forms a natural harbor. Fish abound in the lagoon, but for some reason their meat is frequently poisonous, while the flesh of the same fish outside the lagoon will be safe to eat.

The volcanic islands are widely distributed. Their sharp rocky masses rise abruptly from the sea, often to great altitudes, forming impressive mountains whose rough outlines are softened by dense vegetation. Rain is more abundant on these islands than on the low atolls because the mountains cause the winds to drop their moisture. The rich soil supports countless valuable plants and trees—the banana, the yam, the sago palm, the breadfruit, and the taro, whose roots ground into paste and allowed to ferment form the famous native dish called *poi*. Here also grows the paper mulberry, whose inner bark is pounded into *tapa* cloth, once widely used for mats and clothing throughout the islands. Wild pigs and goats overrun many of the larger islands, and countless brightly colored birds dwell in the forests of the interior. But everywhere, on islands large or small, the coconut palm waves its plumes over the land where it is king.

Many of the western Pacific islands are composed largely of phosphate of lime, highly prized as a fertilizer, and this has been dug out and exported on a large scale. Several of the larger islands yield important quantities of metal ores. New Caledonia, for example, is second only to Ontario, Canada, in the production of nickel, one of the most useful metals.

THE ORIGIN OF AN ATOLL—ACCORDING TO DARWIN



The generally accepted explanation of how tropical atolls are formed is that given by the famous English naturalist Charles Darwin. He said that the coral animals first build a reef along the shore line of a volcanic peak, as shown in the first picture. Then, as wind and rain gradually wear away and destroy the peak, the reef continues to grow upward (second picture). Finally the peak disappears below the water and leaves only the coral reef enclosing a lagoon (*see* Coral).

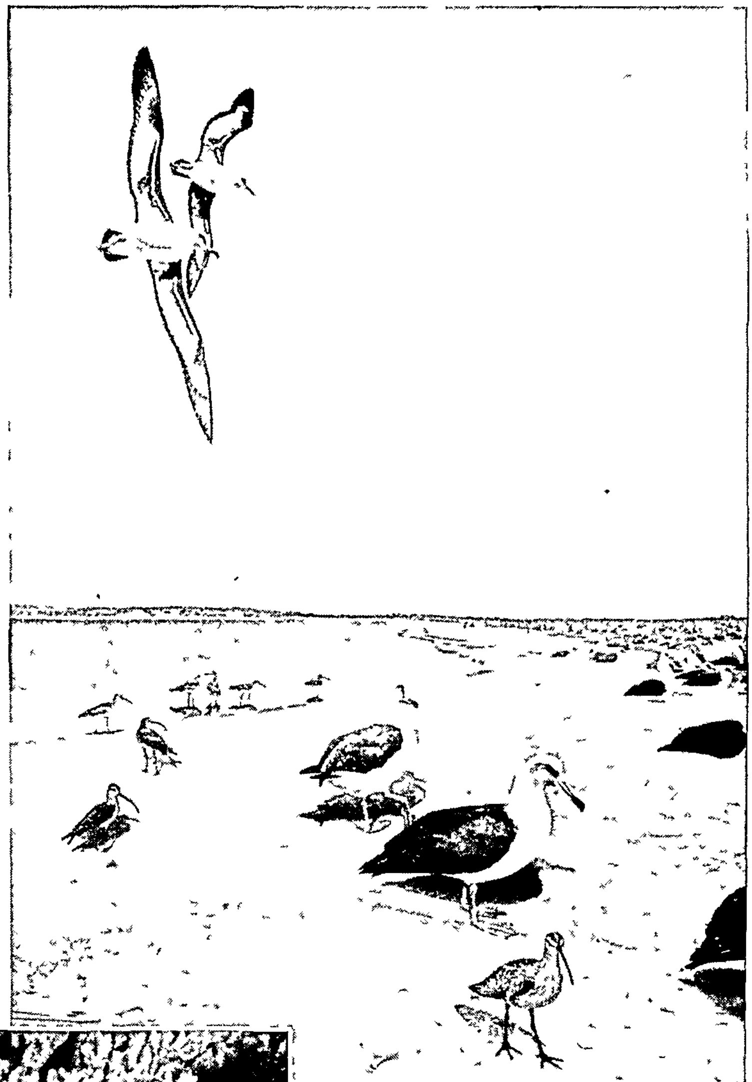
Constant ocean winds moderate the natural heat of the tropics and give the islands an even temperature. In the west, typhoons and hurricanes frequently do great damage, and tidal waves set in motion by submarine volcanoes sometimes sweep over coastal settlements.

History of Pacific Exploration

Marco Polo with his father and uncle may have glimpsed the Pacific Ocean from Chinese waters in the 13th century (*see* Polo, Marco). But the first European to see the eastern Pacific was Balboa, standing on a mountain top in the Isthmus of Panama in the year 1513 (*see* Balboa). Seven years later Ferdinand Magellan sailed around South America and crossed the Pacific to the Philippines, where he was killed (*see* Magellan). He sighted few islands on the way, and stopped only at the Marianas. As early as 1512 the Portuguese had been entering the Pacific from the western side, following Vasco da Gama's voyage around the Cape of Good Hope. Little was accomplished, however, in the way of wider exploration until the 17th century, when the Dutch entered the field, in the person of Abel Tasman, and explored Tasmania (Van Diemen's Land), New Zealand, the Tonga Islands, the Tuamotu group, and the Bismarck Archipelago. The following century Jacob Roggeveen explored Samoa and the neighboring islands. Samuel Wallis and Philip Carteret acting for Great Britain and De Bougainville for France carried out other important voyages of discovery. The greatest of all the explorers, however, was Capt. James Cook, who between 1769 and 1778 made three long trips, visiting nearly all the important eastern groups, including the Hawaiian Islands, where he was killed (*see* Cook, Capt. James). Vancouver and many others followed where these bold mariners had opened the way.

With the close of the period of discovery, in the second quarter of the 19th century, numerous scientific expeditions were organized to study the formation and the life of the Pacific islands, the most famous being those of Charles Darwin, in the British warship *Beagle*, and A. R. Wallace. On their heels came traders, seeking copra, trepang, pearls, tortoise shell, and sandalwood. Whalers and sealers also visited the

LIFE ABOVE AND BELOW THE OCEAN SURFACE



The top picture shows the albatrosses and the smaller curlews which are among the many birds of the Pacific islands. Below, we see parrot fish nosing about in the shallow waters of a reef, among pearl shells and coral.

islands, to refit their vessels and get wood and water. Upon them rests much of the blame for the islanders' misfortunes, for many of the traders and their rough half-pirate crews treated the natives with great barbarity, imported alcoholic drinks, and helped to spread disease. Deserters and shipwrecked sailors often settled in the more hospitable islands, defrauding the inhabitants in trade. These men, who lived from hand to mouth, on the bounty of the natives, came to be known as "beachcombers," a name still applied to the shiftless and drifting white population found scattered over the Pacific.

The practise of kidnaping natives for the South American and Australian labor markets, which prevailed for many years, led to bloody conflicts with the island tribes. This practise and the activities of the "beachcombers" made exceedingly difficult the work of the missionaries, who came to the islands at an early date. Today virtually all the inhabitants of Polynesia and Micronesia profess Christianity, though many of the old religious beliefs are secretly kept alive.

One of the most romantic tales of the Pacific centers about Pitcairn Island, a tiny isolated rock rising 2,000 feet from the sea, southeast of the Tuamotu Archipelago. Here, in 1790, nine mutineers from the British ship *Bounty*, accompanied by six Polynesian men and twelve Polynesian women, sought refuge from the law. They burned their vessel and then fought among themselves. Within ten years only one Englishman, John Adams, eight women, and a number of children were left alive. When this strange colony was discovered, in 1808, Adams had restored order and Christianized his people. The island was annexed to Great Britain in 1839. Seventeen years later its people were removed to Norfolk Island, northwest of New Zealand, but a number of them returned to Pitcairn later. Today Pitcairn has 138 inhabitants (1948 census), nearly all descendants of the original settlers.

BALBOA'S FIRST VIEW OF THE PACIFIC

Vasco Nuñez de Balboa was the first white man to gaze upon the Pacific Ocean from the shores of the New World. Standing upon a peak in the Isthmus of Panama on Sept. 25, 1513, he sighted the "Great South Sea." The famous traveler Marco Polo may have seen the Pacific from the Chinese coast in the 13th century.

The Race for Colonies

The European powers took little interest in the islands of the Pacific until the middle of the 19th century. Then the German government began to annex Pacific colonies; and Great Britain and France soon entered the race. Following the first World War, the German dependencies were mandated to Japan, Australia, and New Zealand.

Most of the islands south of the Equator came under British rule. France obtained the Society Islands, the Marquesas, Tuamotu, and the Tubuai Islands in Polynesia; and New Caledonia, far to the west. It shared with Great Britain the administration of the New Hebrides. The United States acquired only part of Samoa in the South Pacific.

North of the Equator, the United States acquired all the islands east of the International Date Line, including Hawaii. Practically all the islands west of the Date Line were administered by Japan between the two World Wars. The United States ruled only Guam and Wake Island. These, with Midway Island, just east of the Date Line, served as air bases on the route between the Philippines and Hawaii.

The second World War brought sweeping changes, as told in the next section of this article.

The United States and Problems of the Pacific

THE SEARCH for a new route to the Orient was responsible for the discovery of America. Interest in the Pacific Ocean as a highway to the riches of the Far East was therefore part of the heritage of the American colonists. Even before the Revolution, American whaling voyages stimulated adventurous traders to thought of distant lands beyond the Western Ocean. But not until independence was won and the young nation faced the need for new markets, did Pacific trade become a reality. In 1784 the *Empress of China*

THE BIG BASKETS THE SAMOANS CALL HOME

The natives of Samoa display extraordinary skill in weaving these round basket-work huts, which they thatch with palm leaves. *Such huts are airy, waterproof, and very well suited to the mild climate of the islands. With a home like this in the midst of a grove* of coconuts or breadfruit trees, there is no need to worry about the future.

from New York City reached Canton—the first American vessel to engage in trade with China. Three years later the *Columbia* sailed from Boston, rounded Cape Horn, picked up a cargo of furs from Indians on the Pacific coast of North America, and traded them in China for a shipload of tea. This was the pioneer voyage of a colorful, profitable, and steadily increasing trade, in which the furs of the Pacific Northwest were exchanged for the tea, coffee, silk, cotton goods, spices, porcelain, and tin of the Orient.

As this new commerce expanded, the nation at home was pushing its frontier to the Pacific coast. The coast had hardly been reached before some American statesmen viewed it as the "manifest destiny" of the United States to extend its power into the waters beyond. Senator Seward, one of the most enthusiastic of the "expansionists," foresaw this nation as predominant in the Pacific. This ocean, he also said, "will become the chief theater of events" (*see* Seward). In 1853 Commodore Perry led a naval expedition to Japan which resulted in the signing of a commercial treaty—the first that Japan had concluded with any Western nation.

DANCING WHILE SITTING DOWN

Pacific islanders love dancing. Many of their most beautiful pantomime "dances" are those they perform while seated. This Samoan girl is acting out a dramatic story with a complicated series of movements of her hands and of the upper part of her body.

American Acquisitions in the Pacific

During the second half of the 19th century, issues at home absorbed the people, and the extension of American power in the Pacific was the work of a few zealous statesmen. Seward almost alone negotiated the treaty with Russia in 1867 which resulted in the acquisition of Alaska. He also sponsored a law authorizing American citizens, in the name of their government, to take possession of unclaimed and unoccupied Pacific islands for their deposits of guano.

Under this act, between 1856 and 1884, claims were made for 57 Pacific islands, though most of these were abandoned after the guano had been removed. Some of the small islands thus claimed for the United States have recently become important as bases for naval and civil aviation. Among them are the Midway group

northwest of Hawaii—two small islands surrounded by numerous islets—and, to the south, the tiny islands Johnston, Palmyra, Howland, Baker, and Jarvis. Wake Island was especially important as an air base between Hawaii and Guam.

The naval and commercial expeditions which brought these specks of land under the American flag were responsible also for several larger acquisitions. The United States had long taken an active interest in the Hawaiian and Samoan islands and had vied with other nations for control. There was widespread opposition, however, to involving the country in the affairs of such distant lands. Not until the outbreak of war with Spain in 1898, and the consequent upsurge of imperialist sentiment, did the nation embark on a frankly expansionist program in the Pacific.

Results of the War with Spain

The United States went to war with Spain for the avowed purpose of setting Cuba free; but the war ultimately had a far-reaching effect on the American position in the Pacific. Commodore Dewey's destruction of the Spanish fleet in Manila Bay fired the imagination of the American people and provided the setting for bold action. In July 1898 Congress finally ratified the treaty which made the Hawaiian Islands part of the American domain. The peace treaty ending the war with Spain provided for the cession of the Philippine Islands and Guam. The following year, 1899, the United States settled long-standing differences with Great Britain and Germany over Samoa. A treaty gave the United States control of Tutuila, with its excellent harbor, and of several other small Samoan islands. (*See also* Dewey, Admiral George; Guam; Hawaiian Islands; Philippine Islands; Samoa.)

With these swift moves, the United States entered the 20th century as one of the major powers in the Pacific. The opening of the Panama Canal in 1914 stimulated commerce with the Orient and strengthened enormously the naval position of the United States. After the first World War, the country played a leading rôle in Far Eastern affairs. Its trade with the Orient, based largely on the exchange of American industrial products for commodities such as rubber, tea, tin, and silk, continued to expand, reaching a total of a billion dollars annually. And huge investments were made by Americans in the Far East—in China, the Philippine Islands, the Netherlands Indies, Japan, India, and British Malaya.

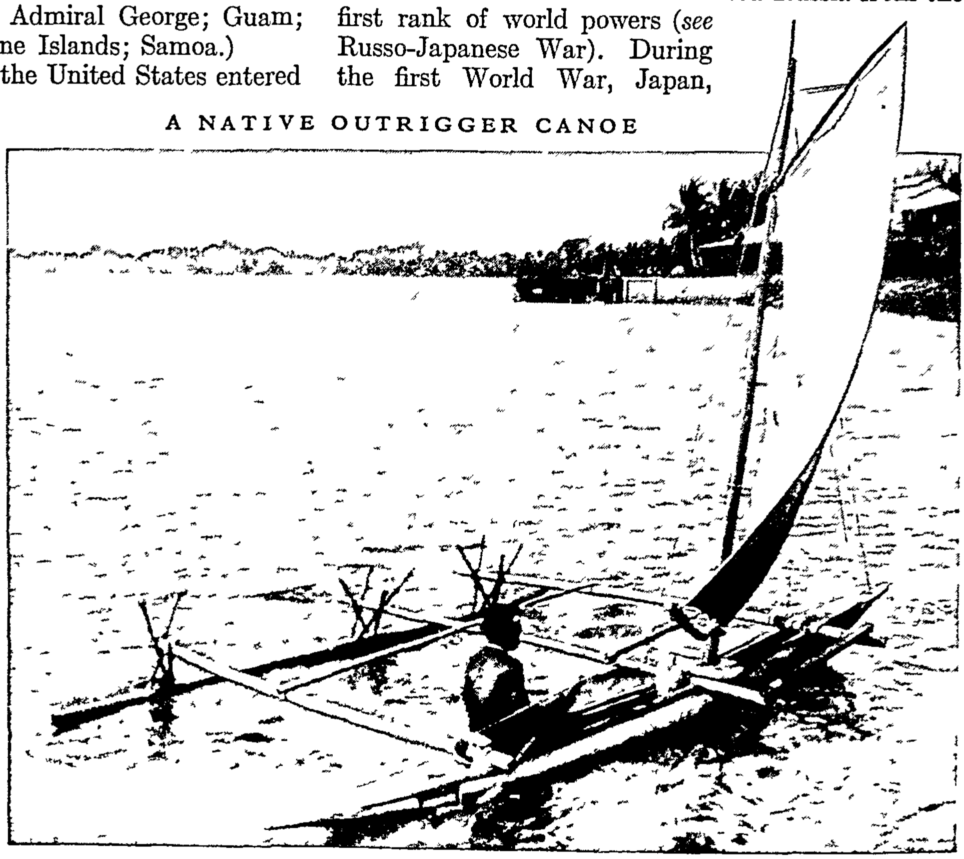
Struggle for Power Becomes Sharp

Toward the end of the 19th century, as the United States assumed power in the Pacific, other nations also were bidding for dominance. The struggle centered at first in China, where vast markets and resources provided tempting opportunities for the industrial nations. The United States, Great Britain, Russia, and France had long contended for economic control in China. A relative newcomer was Japan which, since its opening up to the rest of the world, had sought to solve its problems by expanding abroad.

In 1894 Japan invaded China and swiftly forced the Chinese to accept a humiliating peace giving it large territorial and trade concessions. This action intensified international rivalries and for a time it appeared that China might be divided up among the powers. The United States, to avert this possibility, prevailed upon the nations to accept an "open-door policy," in which each would have equal rights to trade in China.

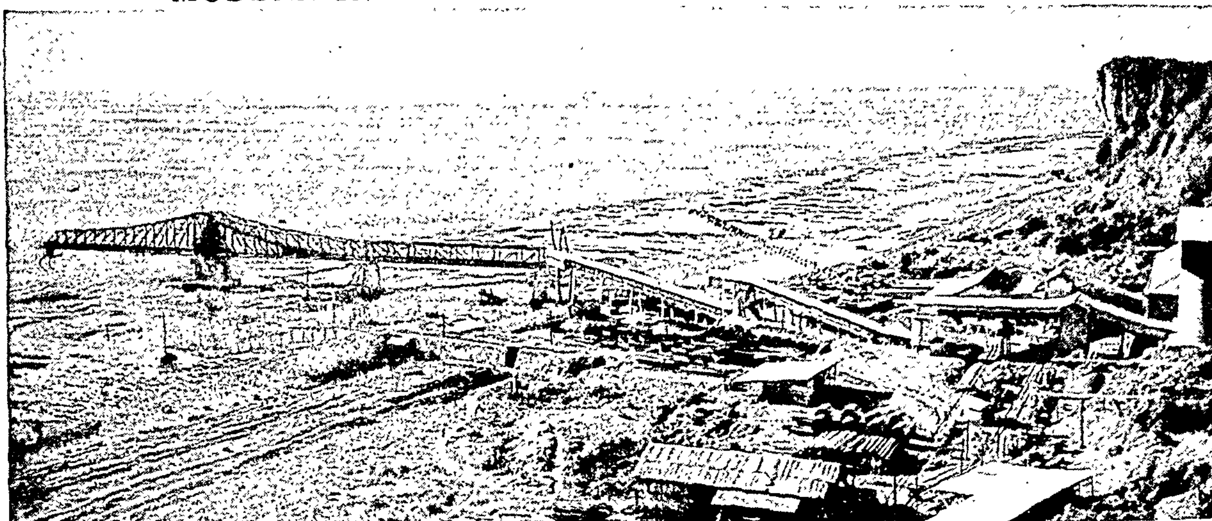
Japan continued to press its advantage, however, and in 1904 attacked Russia in an effort to remove the threat of Russian control of Korea. A decisive victory established Japan as a leading power in the Pacific at the same time that it eliminated Russia from the first rank of world powers (*see* Russo-Japanese War). During the first World War, Japan,

A NATIVE OUTRIGGER CANOE



Nearly all the canoes used by the Pacific islanders are long and extremely narrow. They would be less seaworthy and in constant danger of tipping over were it not for the outrigger structure—a set of poles projecting from the side, at the end of which is fastened a float which rests on the water and holds the craft steady. Many of the canoes carry crude sails, like the one shown here, to aid in their propulsion. When the boatman wants to make greater speed, he tips his canoe so the outrigger is raised clear of the water.

MODERN INDUSTRY INVADES THE SOUTH PACIFIC



Mining and manufacturing industries have been established in some of the Pacific islands which have suitable raw materials. Huge deposits of phosphate, for example, have led to the building of plants such as this one on Makatea Island, near Tahiti. The phosphate is dug out, dried, and then loaded into ships which carry it to many parts of the world to serve as fertilizer.

profiting from the involvement of the Western nations, won from China important concessions in southern Manchuria and eastern Mongolia. At the end of the war, Germany was stripped of its possessions and influence in the Far East. This left four major contenders for Pacific power—Great Britain, the United States, Japan, and France.

Washington and London Conferences

To strike a balance of power and thus avert a disastrous naval race, delegates from the four powers met in Washington in 1921–22, along with representatives of five other nations. The major powers agreed to maintain the *status quo* in the Pacific and to limit their fleets to a scheduled tonnage. All the nations entered into a Nine-Power Treaty guaranteeing China's territorial integrity. (*See also* Harding, Warren Gamaliel.)

A second treaty was negotiated in London in 1930, in which Great Britain, the United States, and Japan promised to preserve the 5-5-3 ratio for battleships established in 1922. But when this treaty came up for renewal in 1936, Japan withdrew (*see* Navy).

For purposes of naval strategy, the Pacific was divided into three zones. The United States, with its fleet based in Hawaii, was dominant in the eastern Pacific as far south as the Samoan Islands. Great Britain, with its Far Eastern fleet based on Singapore, claimed control of the western Pacific south of the Equator. Japan asserted mastery of the northwestern Pacific.

Japan Begins War for Mastery of the Pacific

War shadows began to darken the Pacific horizon after 1931, when Japan began a series of aggressive moves against China. These soon fell into place as part of a grandiose scheme for a "Greater East Asia" under the domination of Japan. When a second World War broke out in 1939, Japan saw an opportunity to realize this vast ambition. Allying itself with the Axis powers in September 1940, after the fall of

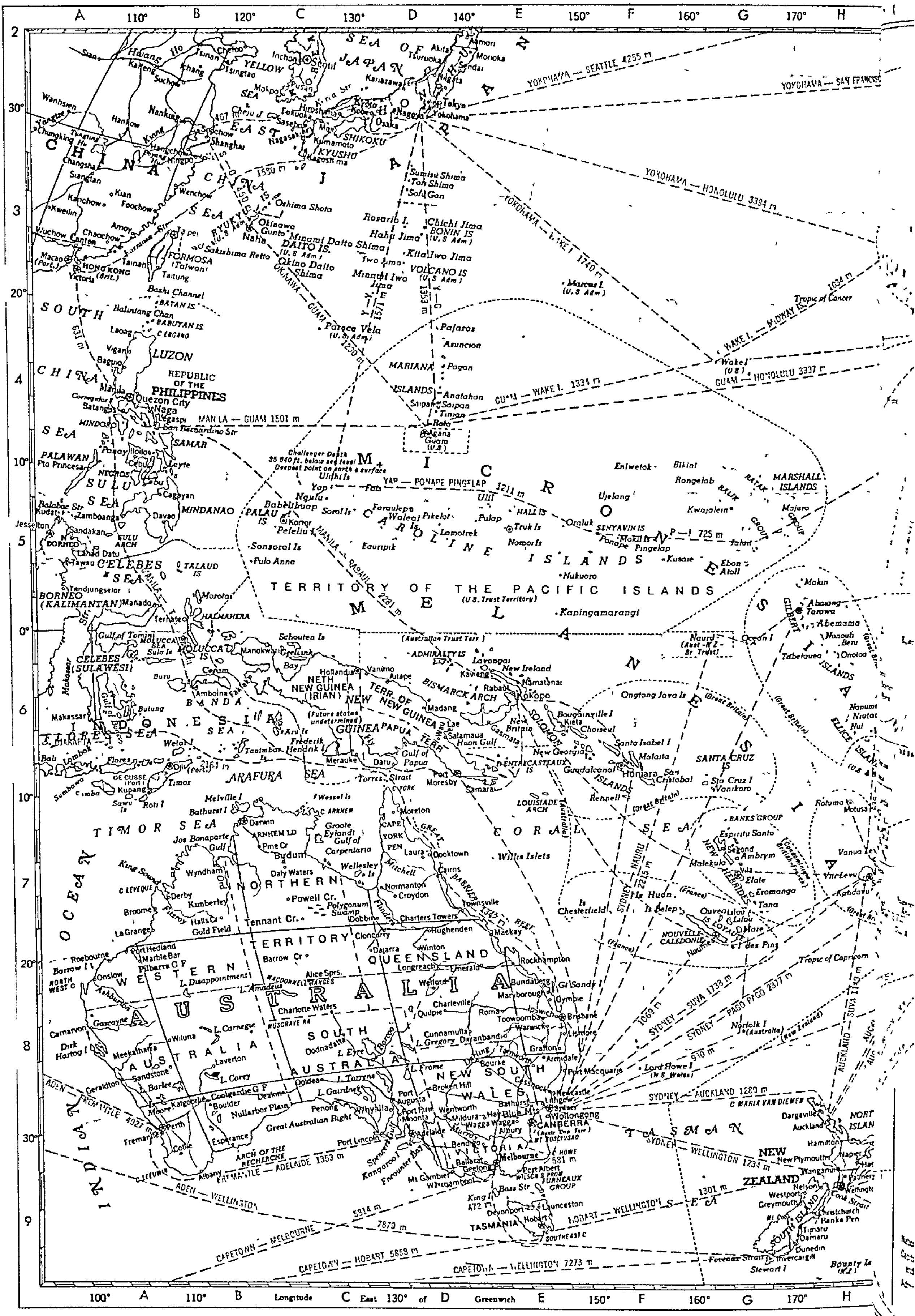
MAKING POI, THE NATIONAL DISH OF HAWAII

Poi is to the Hawaiian, and to many another South Sea islander, what baked beans are to an American—a standard dish. At the left are several of the elephant-eared taro plants, whose starchy roots are the main ingredient of poi. At the right we see a Hawaiian mashing the taro roots into a paste. This is allowed to ferment like sauerkraut, before it is eaten. Few strangers enjoy the taste of it.

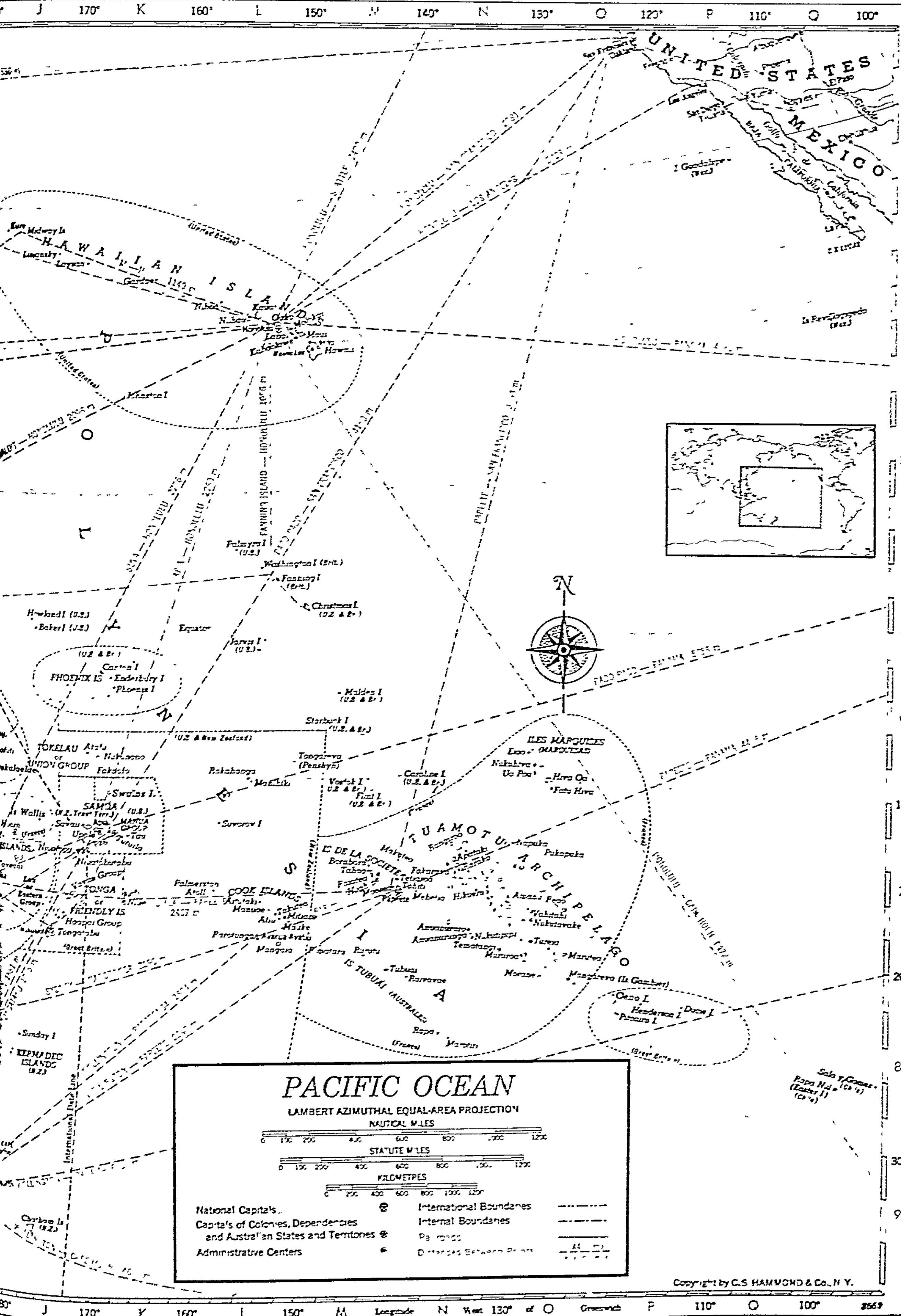
PACIFIC OCEAN*

Abaiang (island)	2,823	H 5
Abemama	1,174	H 5
Adelaide, Aust.	†382,604	E 9
Admiralty (islands)	14,420	E 6
Agana	1,330	E 4
Aitape	161	E 6
Aitutaki (island)	2,356	K 7
Albany, Aust.	4,761	B 9
Albury, Aust.	14,419	E 9
Alice Springs, Aust.	1,871	D 8
Alofi		K 7
Amadeus (lake), Aust.		D 8
Amanu (island)	384	N 7
Ambeno (terr.)	16,660	C 6
Ambrym (island)		G 7
Anatahan (island)		E 4
Anuanuraro (island)		M 8
Anuanurunga (island)		M 8
Apataki (island)	155	M 7
Apia		J 7
Arafura (sea)		D 6
Armidale, Aust.	7,809	F 9
Arnhem (cape), Aust.		D 7
Arnhem Land (region), Aust.		D 7
Ashburton (river)		B 8
Asuncion (island)		E 4
Atafu (island)		J 6
Atiu (island)	1,244	L 8
Auckland, N. Z.	†329,193	H 9
Australes (Tubuai) (islands)	3,915	L 8
Australia	7,579,350	D 8
Australian Capital Terr.	16,905	F 9
Avarua-Avatiu		L 8
Babelthuap (island)	3,672	D 5
Baker (island)	3	J 5
Balabac (strait)		B 6
Ballarat, Aust.	†40,214	E 9
Banks (pen.), N. Z.		H 10
Banks (islands)	2,322	G 7
Barcoo (river), Aust.		D 8
Barlee (lake), Aust.		B 8
Barrow (island), Aust.		B 8
Barrow Creek, Aust.		D 8
Bass (strait), Aust.		E 9
Bathurst, Aust.	11,889	E 9
Bathurst (island), Aust.		C 7
Belep (islands)		G 7
Bendigo, Aust.	†30,778	E 9
Beraoe		B 5
Beru (island)	2,231	H 6
Bikini (island)		G 4
Birdum, Aust.		D 7
Bismarck (archipelago)	133,465	E 6
Blue Mts., Aust.	8,781	E 9
Bonin (Ogasawara) (islands)	146	E 3
Borabora (island)	1,678	L 7
Bougainville (island)	44,143	F 6
Boulder, Aust.	6,463	C 9
Bounty (islands), N. Z.		H 10
Bourke, Aust.	2,025	E 9
Brisbane, Aust.	†402,172	F 8
Broken Hill, Aust.	27,059	E 9
Broome, Aust.	793	C 7
Bundaberg, Aust.	15,921	F 8
Cairns, Aust.	16,641	E 7
Canberra (cap.), Aust.	†15,156	F 9
Canton (island)	81	J 6
Cape York (pen.), Aust.		E 7
Carey (lake), Aust.		C 8
Carnarvon, Aust.	979	B 8
Carnegie (lake), Aust.		C 8
Caroline (island)		M 6
Caroline (islands)	36,980	E 5
Carpentaria (gulf), Aust.		D 7
Cessnock, Aust.	13,030	E 9
Challenger Depth		E 4
Charleville, Aust.	3,458	E 8
Charlotte Waters, Aust.		D 8
Charters Towers, Aust.	7,567	E 7
Chatham (islands), N. Z.	471	J 10
Chesterfield (islands)		F 7
Chichi Jima (island)		E 3
Choiseul (island)		F 6
Christchurch, N. Z.	†174,221	H 10
Christmas (island)	52	L 5
Cloncurry, Aust.	1,584	D 8
Collie, Aust.	4,507	B 9
Cook (strait), N. Z.		H 10
Cook (mt.), N. Z.		G 10
Cook (islands)	14,088	K 7
Cooktown, Aust.	397	E 7
Coolgardie Gold Field, Aust.		C 9
Coral (sea)		F 7
Croydon, Aust.	86	E 7
Cunnamulla, Aust.	1,694	E 8
Daito (islands)		D 3
Dajarra, Aust.	182	E 8
Daly Waters, Aust.		D 7
Dargaville, N. Z.	2,809	H 9
Darling (river), Aust.		E 8
Daru	237	E 6
Darwin, Aust.	2,538	D 7
Deakin, Aust.		C 9
D'Entrecasteaux (islands)	42,392	F 6
Derby, Aust.	326	C 7
Devonport, Aust.	6,156	E 10
Dirk Hartog (island), Aust.		B 8
Dirranbandi, Aust.	514	E 8
Disappointment (lake), Aust.		C 8
Dobbyn, Aust.		D 7
Dokin (Lifou)		G 8
Ducie (island)		O 8
Dunedin, N. Z.	†95,457	H 10
East (cape), N. Z.		H 9
Easter (Rapa Nui) (island)	563	P 8
Eastern Group or Lau (islands)	10,970	J 7
Eauripik (atoll)	138	E 5
Ebon (atoll)	773	G 5
Efate (island)	1,940	G 7
Eiao (island)		M 6
Ellice (islands)	4,487	H 6
Emerald, Aust.	1,336	E 8
Encounter (bay), Aust.		D 9
Enderbury (island)	4	K 6
Eniwetok (island)		G 4
Eromanga (island)	464	H 7
Esperance, Aust.	623	C 9
Espiritu Santo (island)	1,115	G 7
Eyre (lake), Aust.		D 8
Fais (island)	225	E 5
Fakaofo (island)		J 6
Fakarava (island)	210	M 7
Fanning (island)	259	L 5
Faraulep (atoll)	117	E 5
Fatu Hiva (island)	224	N 7
Fiji (islands)	259,638	H 7
Fitzroy (river), Aust.		C 7
Flinders (river), Aust.		E 7
Flint (island)		L 7
Fly (river)		E 6
Foveaux (strait), N. Z.		G 10
Fremantle, Aust.	†27,926	B 9
Friendly or Tonga (islands)	46,870	J 7
Frome (lake), Aust.		E 9
Funafuti (island)	528	J 6
Furneaux (islands), Aust.		F 9
Gairdner (lake), Aust.		D 9
Gambier (Mangareva) (islands)	554	N 8
Gardner (island)	79	K 3
Gascoyne (river), Aust.		B 8
Gasmata		F 6
Geelong, Aust.	†44,641	E 9
Geraldton, Aust.	5,974	B 8
Gilbert (islands)	27,824	H 5
Gisborne, N. Z.	†19,774	H 9
Grafton, Aust.	8,287	F 8
Great Australian (bay), Aust.		C 9
Great Barrier (reef), Aust.		E 7
Great Sandy (island), Aust.		F 8
Gregory (lake), Aust.		E 8
Greymouth, N. Z.	8,865	G 10
Groote Eylandt (isl.), Aust.		D 7
Guadalcanal (island)		F 6
Guam (island)	59,498	E 4
Gympie, Aust.	8,413	F 8
Haapai (islands)		J 8
Haha Jima (island)		E 3
Hall (islands)		F 5
Halls Creek, Aust.	50	C 7
Hamilton, N. Z.	†33,137	H 9
Hastings, N. Z.	†23,797	H 9
Hawaii	499,794	L 3
Hawaii (island)	68,350	L 4
Hay, Aust.	2,971	E 9
Henderson (island)		O 8
Hikueru (island)	167	M 7
Hilo	27,198	L 4
Hiva Oa (island)	836	N 6
Hobart, Aust.	†76,567	E 10
Hollandia (cap.), Neth. N.G.		D 6
Honiara		G 6
Honolulu (cap.), Hawaii	248,034	L 3
Hoorn (islands)	2,000	J 7
Howe (cape), Aust.		F 9
Howland (island)	4	J 5
Huahine (island)	2,462	L 7
Hughenden, Aust.	1,744	E 8
Huon (gulf)		E 6
Huon (islands)		G 7
Invercargill, N. Z.	†31,613	H 10
Ipswich, Aust.	26,218	F 8
Iwo Jima (island)		D 3
Jaluit (atoll)	1,093	G 5
Jarvis (island)	3	K 6
Johnston (island)	69	K 4
Joseph Bonaparte (gulf), Aust.		C 7
Kahoolawe (island)		L 4
Kalgoorlie, Aust.	†22,380	B 9
Kandavu (island)		H 7
Kangaroo (island), Aust.		D 9
Kapingamarangi (island)		F 5
Kauai (island)	29,683	L 3
Kavieng	715	E 6
Kazan (Volcano) (islands)		E 3
Kermadec (islands), N.Z.	23	J 9
Kieta		F 6
Kimberley Gold Field, Aust.		C 7
King (sound), Aust.		C 7
King (island), Aust.	954	E 10
Kita Iwo Jima (island)		E 3
Kokopo		F 6
Korror		D 5
Kosciusko (mt.), Aust.		F 9
Kudat	3,800	B 5
Kure (island)		J 3
Kusaie (island)	1,865	G 5
Kwajalein (atoll)	1,081	G 5
La Grange, Aust.		C 7
Lae	4,146	E 6
Lahad Datu	600	B 5
Lamotrek (atoll)	148	E 5
Lanai (island)	3,136	L 3
Lau or Eastern Group (islands)	10,970	J 7
Launceston, Aust.	†40,449	E 10
Laura, Aust.		E 7
Laverton, Aust.	153	C 8
Lavongai (New Hanover) (island)		F 6
Laysan (island)		J 3
Leeuwin (cape), Aust.		B 9
Leveque (cape), Aust.		C 7
Levuka		H 7
Lifou (island)		G 8
Lifou (Dokin)		G 8
Lisiansky (island)		J 3
Lismore, Aust.	15,211	F 8
Lithgow, Aust.	14,462	F 9
Longreach, Aust.	3,282	E 8
Lord Howe (island)		G 9
Louisiade (archipelago)	10,384	F 7
Loyalty (Loyauté) (islands)	11,100	G 8
Loyauté (Loyalty) (islands)	11,100	G 8
MacDonnell (mt. ranges), Aust.		D 8
Mackay, Aust.	13,500	F 8
Madang	1,550	E 6
Majuro (atoll)	1,275	H 5
Makatea (island)	1,826	M 7
Makin (island)	969	H 5
Malaita (island)		G 6
Malden (island)		L 6
Malekula (island)		G 7
Mamgaia (island)	1,845	L 8
Mangareva (Gambier) (islands)	554	N 8
Manihiki (island)	435	L 7
Manua (islands)	2,819	K 7
Manuae (island)	28	K 7
Marble Bar, Aust.	224	C 8
Marcus (island)		F 3
Mare (island)		G 8
Mariana (is. excl. Guam)	6,286	E 4
Marotiri (island)		M 8
Marquesas (Marquises) (islands)	2,976	N 6
Marquises (Marquesas) (islands)	2,976	N 6
Marshall (islands)	11,033	H 4
Marutea (island)		N 8
Maryborough, Aust.	14,409	F 8
Maui (island)	40,103	L 3
Mauke (island)	879	L 8
Mauna Loa, Hawaii		L 4
Meekatharra, Aust.	524	B 8

*All population figures are taken from the latest official census or estimate available. For date and source of a population figure see article on the appropriate country. † Includes suburbs.



A 110° B 120° C 130° D 140° E 150° F 160° G 170° H
SEA OF JAPAN
YELLOW SEA
EAST CHINA SEA
CHINA
JAPAN
HONSHU
SHIKOKU
KYUSHU
Tokyo
Yokohama
Nagoya
Osaka
Kobe
Kyoto
Niigata
Sendai
Morioka
Akita
Aomori
Tsuruoka
Kanazawa
Hiroshima
Fukuoka
Nagasaki
Kumamoto
Kagoshima
Moji
Mokpo
Pusan
Seoul
Inchon
Chefoo
Tsinan
Tsingtao
Hwang Ho
Suchow
Kaifeng
Nanking
Hankow
Shanghai
Hangchow
Ningpo
Changsha
Siangtan
Kian
Wenchow
Foochow
Kanchow
Kweilin
Amoy
Chaochow
Wuchow
Canton
Macao (Port.)
HONG KONG (Brit.)
Victoria
Wanhsien
Chungking
Yangtze
FORMOSA (Taiwan)
Taipei
Tainan
Taitung
Formosa Str
RYUKYU IS (U.S. Adm.)
Okinawa Gunto
Naha
Sakishima Retto
Oshima Shoto
DAITO IS. (U.S. Adm.)
Minami Daito Shima
Okino Daito Shima
Sumisu Shima
Tori Shima
Sofu Gan
Rosario I.
Chichi Jima
BONIN IS (U.S. Adm.)
Haha Jima
Kita Iwo Jima
Iwo Jima
Minami Iwo Jima
VOLCANO IS (U.S. Adm.)
Marcus I. (U.S. Adm.)
YOKOHAMA — SEATTLE 4255 m
YOKOHAMA — SAN FRANCISCO
YOKOHAMA — HONOLULU 3394 m
YOKOHAMA — WAKE I 1740 m
WAKE I. — MIDWAY IS. 1034 m
Tropic of Cancer
Wake I (U.S.)
GUAM — HONOLULU 3337 m
GUAM — WAKE I. 1334 m
MANILA — GUAM 1501 m
OKINAWA — GUAM 1230 m
1550 m
Bashi Channel
BATAN IS.
Balintang Chan
BABUYAN IS.
Laoag
C. ENGANO
Vigan
Baguio
LUZON
REPUBLIC OF THE PHILIPPINES
Manila
Quezon City
Corregidor I
Batangas
MINDORO
Naga
Legaspi
San Bernardino Str
SAMAR
Leyte
Panay
Iloilo
Cebu
NEGROS
PALAWAN
Pto Princesa
SULU SEA
Cagayan
MINDANAO
Davao
Zamboanga
Balabac Str
Kudat
Jesselton
Sandakan
SULU ARCH
NORTH BORNEO
Lahad Datu
Tawau
CELEBES SEA
TALAUD IS
Tandjungselor
BORNEO (KALIMANTAN)
Manado
Morotai
HALMAHERA
Ternate
Gulf of Tomini
MOLUCCA SEA
Sula Is
MOLUCCA IS
CELEBES (SULAWESI)
Makassar Str
Makassar
Buru
Ceram
Amboina
BANDA SEA
Butung
Gulf of Bone
INDONESIA
FLORES SEA
Lombok
Bali
Sumbawa
Flores
Wetar I
Timor
Dili (Port.)
OE CUSSE (Port.)
Kupang
Sawu Is
Roti I
Tanimbar Is
Aru Is
Frederik Hendrik I
Merauke
Daru
ARAFURA SEA
Torres Strait
Gulf of Papua
Port Moresby
Samarai
SOUTH CHINA SEA
Pajaros
Asuncion
Pagan
MARIANA ISLANDS
Anatahan
Saipan
Tinian
Rota
Agana
Guam (U.S.)
Parece Vela (U.S. Adm.)
Challenger Depth 35 640 ft. below sea level Deepest point on earth's surface
MICRONESIA
Ulithi Is
Yap
Fais
YAP — PONAPE PINGELAP 1211 m
Ngulu
Babelthuap
PALAU IS.
Koror
Peleliu I
Sorol Is
Faraulep
Woleai Is
Pikelot
Ulul
Pulap
HALL IS
Truk Is
Nomoi Is
Lamotrek
Eauripik
Oroluk
SENYAVIN IS
Mokil Is
Ponape
Pingelap
P — J 725 m
Kusaie
CAROLINE ISLANDS
Sonsorol Is
Pulo Anna
MANILA — RABAUL 2281 m
Eniwetok
Bikini
Ujelang
Rongelab
RALIK GROUP
RATAK GROUP
MARSHALL ISLANDS
Kwajalein
Majuro
Jaluit
Ebon Atoll
Nukuoro
TERRITORY OF THE PACIFIC ISLANDS
(U.S. Trust Territory)
Kapingamarangi
MELANESIA
Makin
Abaiang
Tarawa
Abemama
Nonouti
Beru
Tabiteuea
Onotoa
GILBERT ISLANDS
Ocean I
Nauru (Aust-N.Z-Br. Trust)
(Australian Trust Terr)
ADMIRALTY IS
Lavongai
New Ireland
Kavieng
Namatanai
Rabaul
Kokopo
BISMARCK ARCH
Schouten Is
Geelvink Bay
Manokwari
Hollandia
Vanimo
Aitape
NETH NEW GUINEA (IRIAN)
(Future status undetermined)
TERR. OF NEW GUINEA
NEW GUINEA
PAPUA
Madang
Lae
Salamaua
Huon Gulf
New Britain
Gasmata
SOLOMON ISLANDS
Bougainville I
Kieta
Choiseul
New Georgia
Santa Isabel I
Malaita
Guadalcanal
Honiara
San Cristobal
Rennell
Ongtong Java Is
(Great Britain)
D'ENTRECASTEAUX IS
LOUISIADE ARCH
SANTA CRUZ IS
Sta Cruz I
Vanikoro
BANKS GROUP
Espiritu Santo
Malekula
Ambrym
Vila
Efate
Eromanga
Tana
NEW HEBRIDES
(Condominium British-French)
Rotuma Is
ELLICE ISLANDS
Nanumea
Niutao
Nui
FIJI
Vanua Levu
Viti Levu
Kandavu
CORAL SEA
Willis Islets
Is Chesterfield
Is Huon
Is Belep
(France)
Ouvea
Lifou
Mare
IS LOYAUTE
NOUVELLE CALEDONIE
Noumea
I des Pins
SYDNEY — NAURU 2215 m
SYDNEY — SUVA 1738 m
SYDNEY — PAGO PAGO 2377 m
1069 m
910 m
Norfolk I (Australia)
(New Zealand)
Lord Howe I (N.S. Wales)
Tropic of Capricorn
AUCKLAND — SUVA 1143 m
SYDNEY — AUCKLAND 1280 m
SYDNEY — WELLINGTON 1234 m
TASMAN SEA
C MARIA VAN DIEMEN
Dargaville
Auckland
Hamilton
New Plymouth
Napier
Wanganui
Palmerston
Wellington
NORTH ISLAND
NEW ZEALAND
Nelson
Westport
Greymouth
Cook Strait
Christchurch
Banks Pen
Mt Cook
SOUTH ISLAND
Timaru
Oamaru
Dunedin
Invercargill
Foveaux Strait
Stewart I
Bounty Is (N.Z.)
1301 m
HOBART — WELLINGTON
TIMOR SEA
Melville I
Bathurst I
Darwin
C ARNHEM
Wessel Is
ARNHEM LD
Groote Eylandt
Gulf of Carpentaria
Jos Bonaparte Gulf
Pine Cr
Birdum
Daly Waters
Wellesley Is
King Sound
Wyndham
C LEVEQUE
Derby
Kimberley
Fitzroy
Halls Cr
Broome
La Grange
Gold Field
NORTHERN TERRITORY
Powell Cr.
Tennant Cr.
Polygonum Swamp
Dobbyn
Cloncurry
Normanton
Croydon
Mitchell
Flinders
CAPE YORK PEN
C YORK
Moreton
Laura
Cooktown
Cairns
GREAT BARRIER REEF
Townsville
Charters Towers
Hughenden
Mackay
Rockhampton
Winton
Dajarra
Barrow Cr
Alice Sprs.
MACDONNELL RANGES
QUEENSLAND
Longreach
Emerald
Welford
Bundaberg
Gt Sandy I
Maryborough
Gympie
Brisbane
Ipswich
Toowoomba
Warwick
Lismore
Roma
Charleville
Quilpie
Cunnamulla
Dirranbandi
L. Gregory
Bourke
Grafton
Armidale
Tamworth
Port Macquarie
Cessnock
Newcastle
Lithgow
Sydney
Bathurst
Wollongong
Blue Mts
CANBERRA
(Aust Cap Terr)
MT KOSCIUSKO
NEW SOUTH WALES
Broken Hill
Wentworth
Mildura
Hay
Wagga Wagga
Albury
Port Hedland
Marble Bar
Pilbarra G F
Roebourne
Barrow I
Onslow
NORTH WEST C
Ashburton
L. Disappointment
L. Amadeus
WESTERN AUSTRALIA
AUSTRALIA
Charlotte Waters
MUSGRAVE RA
Carnarvon
Gascoyne
L. Carnegie
Wiluna
Meekatharra
Dirk Hartog I
Laverton
Sandstone
L. Carey
Geraldton
Barlee
Moore
Kalgoorlie
Coolgardie G F
Boulder
Deakin
Nullarbor Plain
Perth
Fremantle
Collie
Esperance
ARCH OF THE RECHERCHE
C LEEUWIN
Albany
SOUTH AUSTRALIA
Oodnadatta
L. Eyre
Barcoo
L. Frome
L. Torrens
Oldea
L. Gairdner
Port Augusta
Port Pirie
Whyalla
Penong
Great Australian Bight
Moonta
Adelaide
Port Lincoln
Spencer Gulf
Kangaroo I
Encounter Bay
Mt Gambier
Warrnambool
VICTORIA
Bendigo
Ballarat
Geelong
Melbourne
Port Albert
WILSON'S PROM
C HOWE
581 m
FURNEAUX GROUP
Bass Str
King I
472 m
Devonport
Launceston
TASMANIA
Hobart
SOUTHEAST C
OCEAN
INDIAN
ADEN — FREMANTLE 4927 m
FREMANTLE — ADELAIDE 1353 m
ADEN — WELLINGTON
5814 m
CAPETOWN — MELBOURNE 7879 m
CAPETOWN — HOBART 5858 m
CAPETOWN — WELLINGTON 7273 m
2161 m
1743 m
1571 m
1353 m
631 m
100° A 110° B Longitude C East 130° of D Greenwich E 150° F 160° G 170° H


PACIFIC OCEAN
LAMBERT AZIMUTHAL EQUAL-AREA PROJECTION
NAUTICAL MILES
STATUTE MILES
KILOMETRES
National Capitals
Capitals of Colonies, Dependencies and Australian States and Territories
Administrative Centers
International Boundaries
Internal Boundaries
UNITED STATES
MEXICO
HAWAIIAN ISLANDS
TUAMOTU ARCHIPELAGO
ILES MARQUISES
COOK ISLANDS
TONGA or FRIENDLY IS.
SAMOA
TOKELAU
UNION GROUP
PHOENIX IS.
IS. TUBUAI (AUSTRALES)
KERMADEC ISLANDS
International Date Line
Equator
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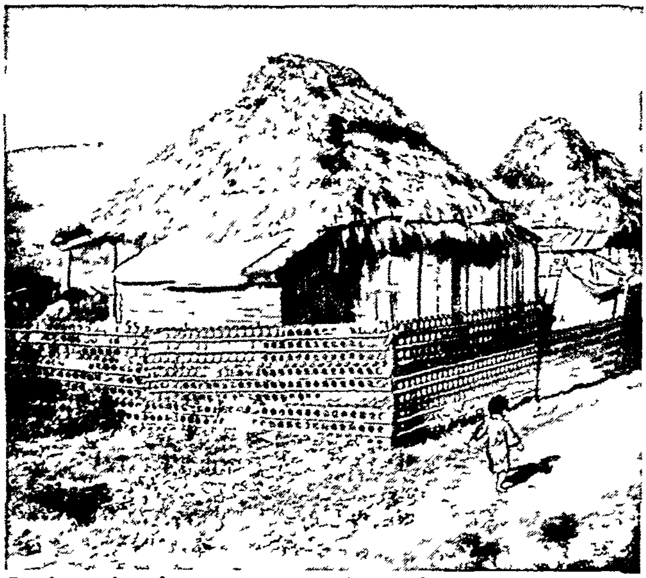
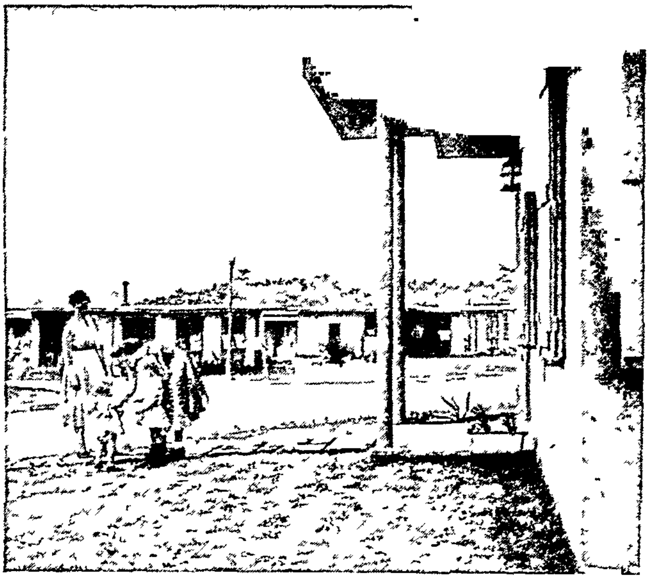
PACIFIC OCEAN—*Continued*

Mehetia (island)		M 7
Melanesia (islands)		G 6
Melbourne, Aust.	†1,226,923	E 9
Melville (island), Aust.		C 7
Micronesia (islands)		G 5
Midway (islands)	437	J 3
Mildura, Aust.	9,528	E 9
Minami Daito Shima (island)		D 3
Minami Iwo Jima (island)		E 3
Mitchell (river), Aust.		E 7
Mitiaro (island)	252	L 7
Mokil (islands)	311	G 5
Molokai (island)	5,280	L 3
Moonta, Aust.	1,221	D 9
Moore (lake), Aust.		B 9
Moorea (island)	2,848	L 7
Morane (island)		N 8
Moreton, Aust.		E 7
Motusa		H 7
Mount Gambier, Aust.	6,787	D 9
Murray (river), Aust.		E 9
Mururoa (island)		M 8
Musgrave (mt. range), Aust.		D 8
Namatanai	315	F 6
Nanumea (island)	746	H 6
Napier, N. Z.	†24,538	H 9
Napuka (island)	250	N 7
Nauru (island)	3,269	G 6
Nelson, N. Z.	†20,497	H 10
New Britain (isl.)	85,115	F 6
New Caledonia (island)	61,250	G 8
Newcastle, Aust.	127,188	F 9
New Georgia (island)		F 6
New Guinea, Neth.	1,000,000	D 6
New Guinea, Territory of	1,100,258	E 6
New Hanover (Lavongai) (island)		F 6
New Hebrides (islands)	47,000	G 7
New Ireland (island)	33,930	F 6
New Plymouth, N. Z.	†24,923	H 9
New South Wales (state), Aust.	2,984,838	E 9
New Zealand	1,939,472	G 10
Ngulu (atoll)	53	D 5
Nihoa (island)		K 3
Niihau (island)	222	K 3
Niuafoou (island)		J 7
Niuatobutabu (island)		J 7
Niue (island)	4,253	K 7
Niutao (island)		H 6
Nomoi (islands)		F 5
Nonouti (island)	2,004	H 6
Norfolk (island)	938	G 8
Normanton, Aust.	234	E 7
Northern Territory, Aust.	10,868	D 7
North West (cape), Aust.		B 8
Noumea (cap.), New Cal.	10,500	G 8
Nouvelle Caledonie (island)	61,250	G 8
Nui (island)	490	H 6
Nukualofa		J 8
Nukuhiva (island)	311	M 6
Nukulaelae (island)	282	J 6
Nukunono (island)		J 6
Nukuoro (atoll)	208	F 5
Nukutavake (island)	162	N 7
Nukutipipi (island)		M 8
Nullarbor (plain), Aust.		C 9
Oahu (island)	353,020	L 3
Oamaru, N. Z.	8,119	H 10
Ocean (island)	2,060	G 6
Oeno (island)		N 8
Ogasawara (Bonin) (islands)	146	E 3
Okino Daito Shima (island)		D 3
Ongtong Java (islands)		G 6
Onotoa (island)	1,491	H 6
Onslow, Aust.	180	B 8
Oodnadatta, Aust.	130	D 8
Ooldea, Aust.		D 9
Oraluk (island)		F 5
Ord (river), Aust.		C 7
Ouvea (island)		G 7
Pagan (island)		E 4
Pago Pago	1,586	J 7
Pajaros (Uracas) (island)		E 3
Palau (islands)	6,596	D 5
Palmerston North, N. Z.	†32,908	H 10
Palmerston (atoll)	65	K 7
Palmyra (island)	32	K 5
Papeete	12,428	M 7
Papua (terr.)	375,966	E 6
Papua (gulf)		E 6
Parece Vela (island)		D 3
Peleliu (island)	846	D 5
Penong, Aust.	118	D 9
Penrhyn (Tongareva) (island)	654	L 6
Perth, Aust.	†272,586	B 9
Phoenix (island)		K 6
Phoenix (islands)	984	J 6
Pikelot (island)		E 5
Pilbarra Gold Field, Aust.		C 8
Pine Creek, Aust.	91	D 7
Pingelap (island)	618	G 5
Pins (island)	570	H 8
Pitcairn (island)	138	O 8
Polygonum (swamp), Aust.		D 7
Polynesia (islands)		K 6
Ponape (island)	6,316	F 5
Port Albert, Aust.	207	E 9
Port Augusta, Aust.	4,351	D 9
Port Hedland, Aust.	328	C 8
Port Lincoln, Aust.	3,963	D 9
Port Macquarie, Aust.	2,906	F 9
Port Moresby (cap.), Papua	17,546	E 7
Port Pirie, Aust.	12,030	D 9
Powell Creek, Aust.		D 7
Pukapuka (island)	141	N 7
Pulap (island)	187	F 5
Pulo Anna (island)	16	D 5
Queensland (state), Aust.	1,106,269	E 8
Quilpie, Aust.	640	E 8
Rabaul	7,600	F 6
Raiatea (island)	4,505	L 7
Raivavae (island)	746	M 8
Rakahanga (island)	318	K 6
Ralik (islands)		G 5
Rangiroa (island)	592	M 7
Rapa (island)	299	M 8
Rapa Nui (Easter) (island)	563	P 8
Raraka (island)		M 7
Rarotonga (island)	5,828	K 8
Ratak (islands)		G 4
Reao (island)	382	N 7
Recherche (archipelago), Aust.		C 9
Reinga (cape), N. Z.		H 9
Rennell (island)		F 7
Rimatara (island)	695	L 8
Rockhampton, Aust.	34,983	F 8
Roebourne, Aust.	136	B 8
Roma, Aust.	3,880	E 8
Rongelab (atoll)	95	G 4
Rosario (island)		E 3
Rota (island)	686	E 4
Rotuma (island)		H 7
Rurutu (island)	1,166	L 8
Saint Albans, Aust.		D 8
Saipan		E 4
Saipan (island)	4,943	E 4
Sala y Gomez (island)		Q 8
Salamaua		E 6
Samarai	777	E 7
Samoa (islands)		J 7
Samoa, American	18,937	J 7
Samoa, Western (N. Z.)	68,197	J 7
San Cristobal (island)		G 7
Sandstone, Aust.	101	B 8
Santa Cruz (island)		G 7
Santa Cruz (islands)		G 6
Santa Isabel (island)		G 6
Savaii (island)		J 7
Sawoe (islands)	4,172	C 7
Segond		G 7
Senyavin (islands)		F 5
Societé (Society) (islands)	41,798	L 7
Sofu Gan (island)		E 3
Solomon (islands)	94,965	F 6
Sonsorol (islands)		D 5
Sorol (islands)	14	D 5
South Australia (state), Aust.	646,073	D 8
Southeast (cape), Aust.		E 10
Spencers (gulf), Aust.		D 9
Starbuck (island)		L 6
Stewart (island)	576	G 10
Sumisu (island)		E 2
Sunday (island), N. Z.		J 8
Suva (cap.), Fiji Is.	11,398	H 7
Suvorov (island)		K 7
Swains (island)	164	K 7
Sydney, Aust.	†1,484,434	F 9
Tabetauea (island)	3,784	H 6
Tahaa (island)	3,256	L 7
Tahiti	29,684	M 7
Takutea (island)		L 7
Tamworth, Aust.	12,071	E 8
Tana (island)	5,869	H 7
Tandjungselor	1,991	B 5
Tarawa (island)	3,582	H 5
Tasman (sea)		G 9
Tasmania (state), Aust.	257,078	E 10
Tau (island)	1,698	K 7
Taveuni (island)		J 7
Tawao	2,000	B 5
Tematangi (island)		M 8
Tennant Creek, Aust.	567	D 7
Ternate	7,126	C 5
Tetiaroa (island)		M 7
Timaru, N. Z.	†22,851	H 10
Timor (sea)		B 7
Tinian (island)	368	E 4
Tokelau or Union Group (islands)	1,388	J 6
Tonga or Friendly (islands)	46,870	J 7
Tongareva (Penrhyn) (island)	654	L 6
Tongatabu (island)		J 8
Toowoomba, Aust.	33,326	F 8
Tori (island)		E 2
Torrens (lake), Aust.		D 9
Torres (strait)		E 6
Townsville, Aust.	34,233	E 7
Truk (islands)	10,252	F 5
Trust Terr., U. S. (islands)	54,843	F 5
Tuamotu (archipelago)	6,692	M 7
Tubuai (island)	1,007	M 8
Tubuai (Australes) (islands)	3,915	L 8
Tureia (island)	70	N 8
Tutuila (island)	15,556	K 7
U. S. Pacific Trust Terr. (islands)	54,843	F 5
Ua Pou (island)	684	M 6
Ujelang (atoll)	247	F 5
Ulil (islands)		F 5
Ulithi (islands)	433	D 4
Union Group or Tokelau (islands)	1,388	J 6
Upolu (island)		J 7
Uracas (Pajaros) (island)		E 3
Vahitahi (island)	69	N 7
Vaitupu (island)	728	H 6
Vanikoro (island)		G 7
Vanimo		E 6
Vanua Levu (island)		H 7
Vavau (islands)		J 7
Victoria (state), Aust.	2,054,701	E 9
Vila		G 7
Viti Levu (island)		H 7
Volcano (Kazan) (islands)		E 3
Vostok (island)		L 7
Wagga Wagga, Aust.	15,351	E 9
Wake (island)		G 4
Wallis (islands),	4,500	J 7
Wanganui, N. Z.	†29,717	H 9
Warrnambool, Aust.	9,997	E 9
Warwick, Aust.	7,130	F 8
Washington (island)	158	L 5
Wau	1,865	E 6
Welford, Aust.		E 8
Wellesley (islands)		D 7
Wellington (cap.), N. Z.	†133,414	H 10
Wentworth, Aust.	2,528	E 9
Wessel (islands)		D 7
Western Australia (state), Aust.	502,480	C 8
Westport, N. Z.	5,505	H 10
Whyalla, Aust.	7,845	D 9
Willis (islands)		F 7
Wilson's (promontory), Aust.		E 9
Wiluna, Aust.	576	C 8
Winton, Aust.	1,351	E 8
Woleai (islands)	399	E 5
Wollongong, Aust.	18,116	F 9
Wyndham, Aust.	458	C 7
Yap (islands)	2,709	D 5
York (cape), Aust.		E 7

ON OKINAWA—GREAT AMERICAN MILITARY BASE IN THE PACIFIC



Steel matting from a wartime airfield fences this thatched hut. The battles in 1945 destroyed most of the timber. American *administrators are striving to improve native housing.*



On the southern third of the island, the area developed by the armed forces, new American homes look like those in a modern suburb. *These are typhoonproof. Here are two "army families."*

France, Japan forced the defeated French to admit Japanese troops into Indo-China. On Dec. 7, 1941 (United States time), they attacked American and British bases from Singapore to Pearl Harbor. In a few weeks they captured Singapore, the Philippines, and the East Indies. Within six months they extended their control from the borders of India eastward to the International Date Line and southward to about 10 degrees below the equator. Their "Greater East Asia Co-prosperity Sphere" then embraced nearly one quarter of the people of the world.

From August 1942 to mid-1945 the United States fought its way back over the islands of the Pacific. In the spring of 1945 the American forces approached the Japanese mainland with the seizure of Iwo Jima in the Volcano Islands and Okinawa, largest in the Ryukyu chain. Japan's last hold on the Pacific was smashed when American fliers dropped an atomic bomb—the first used in war—on Hiroshima, August 6 (Far Eastern time). Two days later Russia declared war on Japan. The Japanese surrendered on August 15, but Russian forces continued into Manchuria.

World War II Revolutionizes the Far East

The first World War had little effect on the Far East. World War II, however, changed nearly all the Orient and virtually wiped out the West's holding in Asia. Colonies demanded independence. The Dutch were forced to free the East Indies, which became the Republic of Indonesia. France had to give local government to Indo-China, accepting its three states as members of the French Union. The states were Cambodia, Laos, and Viet Nam. The West gave up extraterritorial rights in China.

The United States had already arranged to withdraw as a Pacific power. On July 4, 1946, it fulfilled an earlier pledge to free the Philippine Islands, which became the Republic of the Philippines. The war, however, had shown need for strategic American bases in the Pacific. In 1947 the United Nations granted the United States trusteeships over the Marianas, Marshalls, and Carolines. The United States kept control of the Bonins and Okinawa, where it built air and naval bases.

The Marshalls became a proving ground for United States nuclear fission weapons. After the natives had been moved, atom bombs were exploded off Bikini in 1946 and on Eniwetok atoll in 1948 and 1951. In 1952 it exploded the first hydrogen bomb, off Eniwetok; and, in 1954, exploded a massive H-bomb off Bikini. Terrified natives of the Marshalls asked that such tests be stopped in the area, at least until greater safeguards were installed.

March of Communism and Measures to Halt It

The trustees administering the islands set up a South Pacific Commission in 1947 to help the natives improve public health and agricultural methods. The islands made gradual but marked progress.

In the larger land areas of the Pacific, however, the poverty and discontent of the people led many of them to accept Communism as a possible solution to their problems. China fell to the Communists in 1949. Communists invaded South Korea in 1950 and also threatened to win Indo-China in 1954.

In an effort to keep South and Southeast Asia from the Communist advance, the democracies worked out various plans. In 1950 the British Commonwealth nations set up the Colombo Plan. This program, with Point Four aid from the United States, aimed to improve the technology and the health and economic conditions of Asiatic and Pacific lands.

To meet the threat of Communist aggression in the Pacific, the United States in 1952 signed mutual defense pacts with Australia, New Zealand, and the Philippines. In 1954 the United States suggested that a Southeast Asia Alliance be formed, similar to the North Atlantic Treaty Organization (NATO).

PADEREWSKI (*păd-ĕ-rĕf'-skē*), IGNACE JAN (1860–1941). Until Paderewski was 24 years old, his teachers and associates told him he would never be a concert pianist. "You don't have the hands for the piano." He persisted, and became one of the greatest pianists of all time, ranking with Franz Liszt and Anton Rubenstein. In addition to winning world fame as a pianist and composer, he became premier of Poland and gave much of his fortune to aid that nation.

He was born Nov. 6, 1860, in the village of Kurylowka in southwestern Russia, a region which originally was Polish. His father, manager of several large estates, encouraged the boy's love of nature and music. When only three years old, Jan began to pick out notes on the piano.

His father took part in the Polish uprisings of 1863–64. One morning the Cossacks seized him and then struck terrified Jan with a leaded whip. He never lost his hatred of Russia. At the age of 12, Jan entered the Conservatory at Warsaw, where his teachers had him specialize in the trombone. He graduated in 1878, then taught piano there until 1883. The great Polish actress Helena Modjeska then persuaded him to resume his piano studies, in 1884.

He began his concert career in Vienna in 1887, then played in Paris and London. He made the first of many American concert tours in 1891. With his mane of red-gold hair and quick, intense gestures, he made a dramatic appearance on the stage. In 1897 he endowed the Paderewski Fund to give prizes every three years for the best works by American composers.

After World War I he became the first premier of the Republic of Poland. He retired in 1919. In 1921 he settled near Paso Robles, Calif. When Poland was conquered in World War II, he accepted the presidency of the Polish parliament in exile in 1940. His compositions include 'Minuet in G'; an opera, 'Manru'; 'Fantaisie Polonaise'; and 'Symphony in B Minor'. In 1936 he appeared in a motion picture, 'Moonlight Sonata'. His 'Memoirs' were published in 1938. He died June 29, 1941, and was buried in Arlington National Cemetery.

PAGEANT. Through the summer at Williamsburg, Va., scores of brilliantly costumed men and women enact a pageant, 'The Common Glory', which portrays memorable events in the history of colonial Virginia. Written by Paul Green, it was first produced in 1948. Since World War II, pageants such as this have taken on new popularity. Other notable historical pageants include Green's 'Lost Colony', presented at Mantee, N. C., portraying Sir Walter Raleigh's tragic colony on Roanoke Island; and Kermit Hunter's 'Forever This Land', given at New Salem State Park, Ill., showing the life of Abraham Lincoln as a young man.

This form of pageant tells the story in dialogue as well as in spectacle. Some also have musical accompaniment, and some include interpretative dancing. Each has a large cast of characters, and performances are usually given outdoors.

This kind of drama was created by a British playwright, Louis N. Parker, in 1905. That year, at Sherborne in England, Parker produced a pageant celebrating the town's 1,200th anniversary. Residents of all ages took part in this first modern pageant.

American cities soon began similar productions to celebrate their local history. Within a few years they developed other pageant forms, such as the masque, civic festival, and school celebrations of special occasions such as Christmas. Today many of the school productions are entirely the work of the students. They write the book and music and design and make the costumes and scenery.

Medieval "Pageant" and Pageant Parades

The medieval "pageant" was not a group spectacle. It was merely the name for the wagon stage on which players performed miracle and mystery plays (*see* Miracle Plays). Later the word "pageant" came to mean a spectacular procession. Stately parades commemorating religious and historical events have long been a custom in European cities.

One of the earliest of such historical pageants was a parade held in 1888 in Marietta, Ohio. Costumed residents portrayed the history of the community.

Later other cities developed special annual pageant parades. Among the best known is the procession during the Mardi Gras each year in New Orleans, La. Other notable pageant parades include the great line of floral floats for the Tournament of Roses in Pasadena, Calif.; the Festival of the Veiled Prophet in

FLOAT IN A PAGEANT PARADE

Every New Year's Day the city of Pasadena, Calif., stages its Tournament of Roses. The civic pageant, inspired by the flower fetes in Nice, Italy, began as a village festival in 1890.

St. Louis, Mo., and the Mummers' Parade in Philadelphia, Pa., on New Year's Day. Many towns and even villages put on pageant parades for such special occasions as flower, fruit, and harvest festivals, patriotic holidays, school homecomings, and the community's centennial. In recent years communities have developed a new kind of pageant—a festival displaying the produce for which the region is especially noted. Every year, for example, some communities stage festive celebrations for "Sweet Corn Day," "Milk Day," and, in one Illinois region, "Sauerkraut Day."

PAINE, THOMAS (1737–1809). Small, wiry Tom Paine was the "firebrand of the American Revolution." His fiery writings brought courage in times of crisis. The first was in January 1776. At that time, the colonies were still split on the question of declaring independence of England. Some instructed their delegates in the Continental Congress to act against separation from the "mother country." Thousands of colonists were undecided. On January 10, Paine published a little pamphlet, 'Common Sense'. To rally the faltering, he wrote: "Freedom has been hunted around the globe. Asia and Africa have expelled her . . . and England has given her warning to depart. O, receive the fugitive and prepare in time an asylum for mankind!"

Colonists up and down the seaboard read this stirring call to action. Washington himself said it turned doubt into decision—for independence.

Restless Youth and Manhood

Paine was born in Thetford, England. His mother was an Anglican; his father, a corset maker, was a Quaker. The family was poor and, at 13 years of age Tom left school to work for his father. At 19 the restless lad shipped out on a privateer in the Seven Years' War. In a few months, however, he left and became an apprentice to a London manufacturer.

During the next few years he jumped from job to job, finally becoming an exciseman, or collector of internal revenue taxes. Meanwhile, he studied widely, especially in science and mechanics. He neglected his excise duties and was dismissed in 1774.

He sailed for America, carrying letters of introduction from Benjamin Franklin, whom he had met in London. Franklin recommended him for the "genius in his eyes." Franklin's letters got him the post of assistant editor of the new *Pennsylvania Magazine* in Philadelphia; Paine's first essay deplored slavery in the colonies. He always struck for freedom.

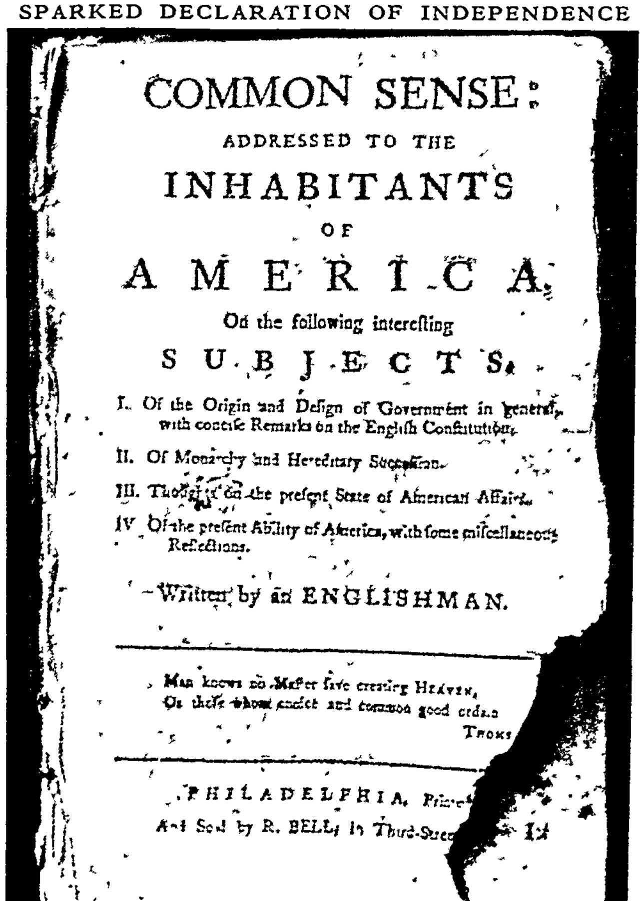
He served for a time in the Continental army, sharing the hardships of the ill-equipped, hard-pressed American troops. He saw the mounting discouragement and so, on Dec. 23, 1776, he started publishing 'The Crisis', a series of 16 pamphlets. It began with the challenging words: "These are the times that try men's souls." Washington ordered it read to "every corporal's guard in the army."

Paine was given a major post in the Continental government but he indiscreetly published confidential information and was forced to resign in 1779. After the Revolution, Congress and the states of New York and Pennsylvania granted him land and money.

He returned to England in 1787. There he published 'The Rights of Man' in support of the French Revolution. Today the book seems moderate, but it so stirred England that he was indicted for treason. Fleeing to France, he was elected to the Convention, where he opposed the execution of Louis XVI. His humanitarian stand won him the ill will of the Jacobins, and he escaped the guillotine only through the fall of Robespierre. After ten months in prison he was released and aided by James Monroe, then American ambassador to France and later president.

Paine, in 1796, wrote that President Washington had neglected him. This unjustified attack and his criticism of the Bible, in his 'Age of Reason', lost him many friends. He was, however, not an atheist, but a deist. He returned to America in 1802. An outcast and in ill health, he wandered from place to place until his death on June 8, 1809, in New York City.

SPARKED DECLARATION OF INDEPENDENCE



COMMON SENSE;
ADDRESSED TO THE
INHABITANTS
OF
AMERICA,
On the following interesting
SUBJECTS.
I. Of the Origin and Design of Government in general, with concise Remarks on the English Constitution.
II. Of Monarchy and Hereditary Succession.
III. Thoughts on the present State of American Affairs.
IV. Of the present Ability of America, with some miscellaneous Reflections.
Written by an ENGLISHMAN.
Man knows no Master save creating Heaven,
Or those whom choice and common good ordain.
Thomson.
PHILADELPHIA, Printed
And Sold by R. BELL, in Third-Street.

Here is the cover of Paine's history-making pamphlet, 'Common Sense'. The author of the 47-page essay is given only as "Written by an Englishman," following the day's custom of anonymity.

Renoir, Pierre Auguste (1841–1919), French.
TWO LITTLE CIRCUS GIRLS.
1879. Oil on canvas. 51¼ in. x 38¾ in. Art Institute of Chicago, Chicago, Ill.

The ARTISTIC INTERPRETATION *of* LIFE *and* NATURE

Botticelli, Sandro, or Alessandro di (1444?–1510), Italian.
PORTRAIT OF A YOUTH.
About 1484. Tempera on wood. 16 in. x 12 in.
Mellon Collection.
National Gallery of Art, Washington, D. C.

PAINTING. 'Two Little Circus Girls', by the French artist Auguste Renoir (*rĕ-nwȧr'*), is a painting about which everyone has a pleasant feeling. Even at first glance one likes this painting of two young performers in the circus who are receiving the applause of the audience.

We are struck at once by their natural, unaffected charm and dignity. They are like girls we might expect to meet in a school or at a summer camp. Renoir is showing us that they are human beings with the same interests and pleasures as the rest of us, in spite of the unusual nature of their work.

Renoir has done many things to make this picture appealing and beautiful. First of all he has shown a sympathetic interest in people by treating these children with warmth and understanding.

Warm Colors and Rounded Forms

Another of the striking features of the picture is its wonderful use of warm colors. The girls have warm, healthy skin and glossy brown hair held in place with golden-yellow ribbons. These colors are repeated in their golden shoes and the fringe on their costumes. One girl is holding several of the balls which they have used in their performance. They are a rich orange. The girls are surrounded by the golden-brown background of the arena floor. All these colors and the dull red railing at the back are warm. Blues and greens, which are cool colors, are used only in very small areas to contrast and heighten the effect.

Renoir's emphasis on full rounded forms is still another device to increase the physical appeal of the picture. Straight lines are apt to be harsh and mechanical; curved lines are soft and attractive. All the major forms are full and rounded. Note especially the orange balls and the heads of the girls. The arms of both of them, especially the one on the left, are arranged in full curves. Curves and rounded forms are also emphasized in the hair ribbons and the lines and decorations on the costumes. The railing which surrounds the circus arena in the background is also rounded in form.

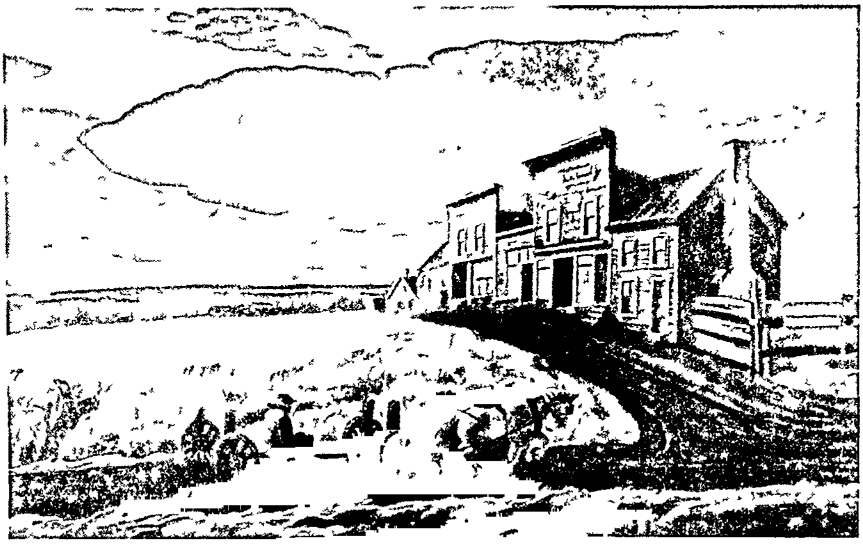
Notice that all the edges in the composition are indefinite. The forms appear to dissolve against each other. Their softness gives the effect of warmth, movement, and energy. Hard edges, like straight lines, tend to be sharp and cold.

Here, then, is a work of art in painting. Renoir was a great artist because he was able to take some aspect of life and give it depth and meaning. To do this he has made use of the many devices common to painting—composition (the arrangement of the objects within a picture), color, form, and texture. All these he has used with such taste, sensitivity, and power that the result is deeply affecting. People who look at the picture are moved by a love for the beauties and wonders of life.

A Botticelli Portrait

Art, of course, is as varied as the life from which it springs. Each artist discovers and portrays different aspects of the world for us. It is interesting to compare 'Two Little Circus Girls' with 'Portrait of a Youth', done almost 400 years earlier by the Italian artist Sandro Botticelli (*bŏt-ĭ-chĕl'ĭ*). He too shows a deep interest in people in this honest and sympathetic portrait. He too has painted his subject almost entirely in warm colors. The browns and reds are deeper and richer than in the Renoir and they give the same feeling of warmth.

Whereas the Renoir has only soft indefinite edges and is full of rich texture, the Botticelli has sharp definite forms and smooth surfaces. There is much more emphasis on line and form and less concern with light and atmosphere. These pictures show how varied, yet how similar, paintings can be.



Burchfield, Charles E. (born 1893), American.
NOVEMBER EVENING.
1932. Oil on canvas. 32⅛ in. x 52 in.
Metropolitan Museum of Art, New York, N. Y.

On the following pages are other examples of great art from many periods and places, chosen to help us enter into the wonderful world of enjoyment and understanding which painting can provide.

Many Different Subjects Are Possible

A painter does not need handsome and attractive subjects such as those we have just seen. He often transforms an ordinary subject through his artistry. Look at 'November Evening' by the American artist Charles Burchfield. Its simple homes and stores are typical of many crossroads towns in the Midwest. Beyond the buildings stretches the vast prairie, and over the whole landscape is a dark autumn sky.

Burchfield has given the scene a real dignity through his honest and open treatment. He has not tried to make the picture "pretty" by hiding the poor proportions of the buildings or their ungainly grouping. By stressing the contrast between the huddled buildings and the great open spaces surrounding them, he gives a feeling of warm human companionship. Land and sky rule the lives of the people in this little community. The buildings reflect the curve of the swell of land on which they rest, as the windows reflect the light of the evening sky. Yet man, for all his awkwardness and clumsiness, still maintains a simple dignity.

'Hopscotch' is another painting of an unexpected subject. The American painter Loren MacIver (*măk-ī'vẽr*) has set down on canvas a small fragment of our world—a patch of asphalt on which some chil-

MacIver, Loren (born 1909), American.
HOPSCOTCH.
1940. Oil on canvas. 27 in. x 35⅞ in.
Museum of Modern Art, New York, N. Y.

dren have been playing. From this simple source she has discovered a world of wonder. The asphalt is no longer just a material with which streets are paved but a substance of fascinating and varied shapes and rich textures. It is a playground for children. The regular chalked lines of the hopscotch are an interesting contrast to the free, irregular shapes of the pavement. In this small scene we also get some hint of the forces of the world. The paving material has bubbled and eroded because of the action of sun, rain, and frost. Miss MacIver has shown that even a commonplace subject has beauty.

Nonobjective Painting

Some artists use no subject at all in their paintings and depend only on forms, colors, and textures to create interest and meaning. Most music makes no attempt to imitate natural sounds, and there is no reason why painting should always make use of natural objects. 'White Lines', by the American I. Rice Pereira (*pĕ-rā'rą*), is a fine example of such "nonobjective" painting. Miss Pereira has constructed her picture entirely with lines and rectangles of different shapes, sizes, colors, and textures. The rectangles appear on top of and next to each other. Some run in one direction, some in another. This is a study in patterns. Like music, it creates beauty from rhythm and harmony.

Why Artists Paint

Briefly it may be said that artists paint to discover truth and to create order. They put into their pictures our common hopes, ideals, and passions and show us their meaning and their value. Creators in all the arts make discoveries about the wonders and beauties of nature and the dignity and nobility of man. They give these an order which enables us to see and understand life with greater depth. Beauty generally results from order but as a by-product, not a primary aim. Not all works of art are beautiful.

In the early part of the 20th century a group of American artists began painting scenes of industrial subjects such as railroad tracks and factories. At the time the pictures were considered ugly and offensive. Yet these pioneers discovered in such subjects much that was beautiful. Today it is commonly accepted that industrial scenes are rich sources of pleasure in art. It was the artist, perceptive and sensitive, who discovered new areas of enjoyment.

The painter intensifies our experiences. By finding new relationships among objects, new forms, and new colors, he shows us things in our environment which we overlooked or ignored. He makes the world about us become alive, rich, beautiful, and exciting.

The painter must feel very deeply about expressing some idea or emotion. The intensity of his interest is essential. Without it no paintings of any worth or importance can be produced.

The subject which an artist selects for a painting depends largely upon the time in which he lives. A painter living in the Middle Ages would probably have picked a religious subject, for that was almost the only kind of topic portrayed at the time. Had he lived in Holland during the 17th century he might have painted portraits, family scenes, or arrangements of dishes, fruits, and flowers, called *still lifes.*

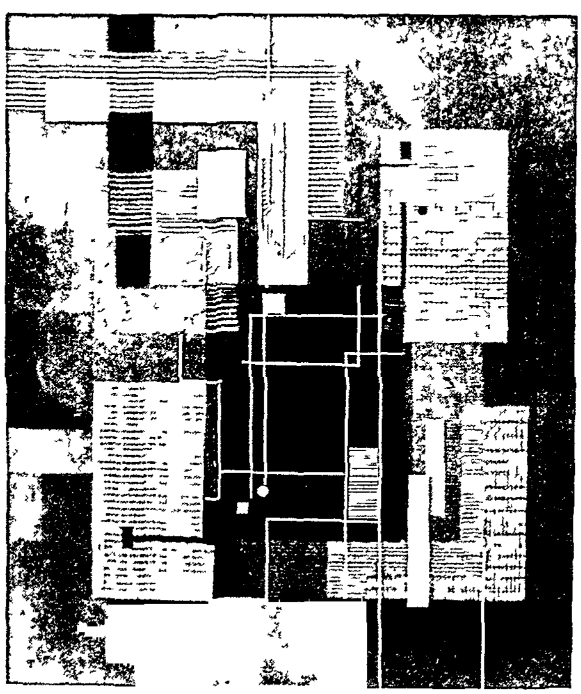
At the present time few artists are painting religious pictures, and portraiture is less important than it was formerly. Many new subjects have become available. The airplane has inspired artists to work on problems of space. The increasing use of machines has led painters to study mechanical forms. Abstract and nonobjective subjects seek to find some basis of order in a rapidly changing world.

In particular, modern painters are concerned with painting the inner world of thoughts, feelings, and dreams. This inner world draws upon very different forms and relationships from the outer world of reality. Such pictures appear strange and difficult to understand because they are so new. Paul Klee's 'Intention' (page 23*b*) and Salvador Dali's 'The Persistence of Memory' (page 34*c*) are examples.

Having selected his subject the painter is faced with the problem of giving it form. Will his idea be communicated best by the use of realistic or abstract forms? Should it be done in bright or in dull colors? Should the effect be exciting or restful? The answer to these and similar questions will be answered only in terms of what the painter is trying to do. In a good painting everything in it grows out of and develops from the intent of the artist.

Four Modern Paintings

The four 20th-century paintings on the next two pages offer interesting contrasts in intent and treat-



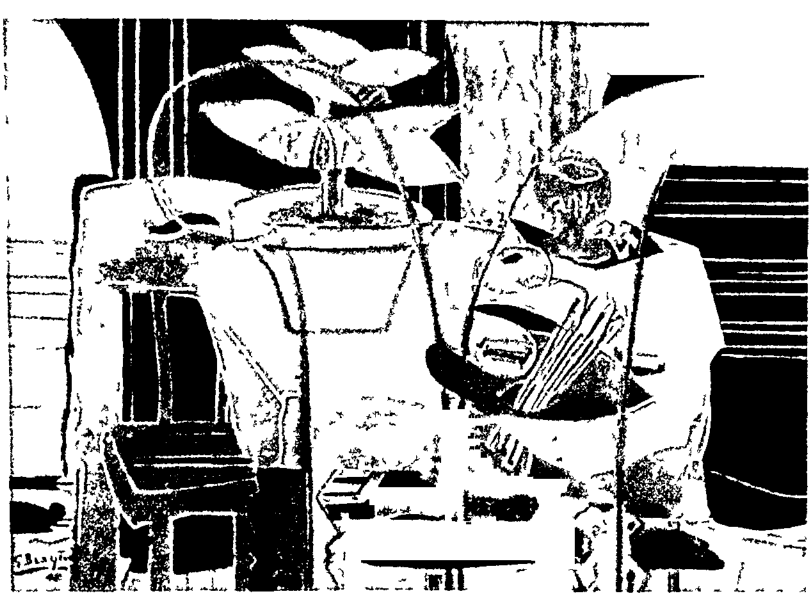
Pereira, I. Rice (born 1907), American.
WHITE LINES.
1942. Oil on vellum. 25⅞ in. x 21⅞ in.
Museum of Modern Art, New York, N. Y.

Hartley, Marsden (1877–1943), American.
MT. KATAHDIN, AUTUMN, No. 1.
1939–40. Oil on canvas. 30⅛ in. x 40 in
Frank M. Hall Collection.
University of Nebraska Art Galleries, Lincoln, Neb.

ment. 'Mt. Katahdin, Autumn', shows personal feelings about the beauties of nature. Marsden Hartley has simplified and intensified the colors and forms which impressed him in the Maine landscape. In the middle ground is a low mountain covered with trees in brilliant fall color. Against it are silhouetted several pines, their stable greens offering a fine contrast to the exciting orange red. Mt. Katahdin itself dominates the picture, strong and solid both in its simple shape and in the dark blue-purple color. Behind the mountain the clouds have been given strong, simple forms like the mountain itself. The water in the foreground reflects all the elements in the scene, combining them into a lively pattern. Hartley has conveyed beauty by intensifying essentials.

In 'Summer Landscape' Stuart Davis has chosen a much less dramatic scene. He has avoided shadows so that all the forms may stand out clearly. The shapes of the buildings are solid and sturdy. Edges of the foliage are lively and playful. Many things, such as fences and clouds, are only indicated with a kind of shorthand. Most of the important elements in the picture are either very dark or very light. The contrast between objects makes sharply clear their relationship to each other and at the same time builds up an energetic pattern of lights and darks. 'Summer Landscape' conveys a feeling of space and joy.

'Interior with Table', by Georges Braque (*bråk*), shows another kind of treatment developed by contemporary artists. We recognize a table on which



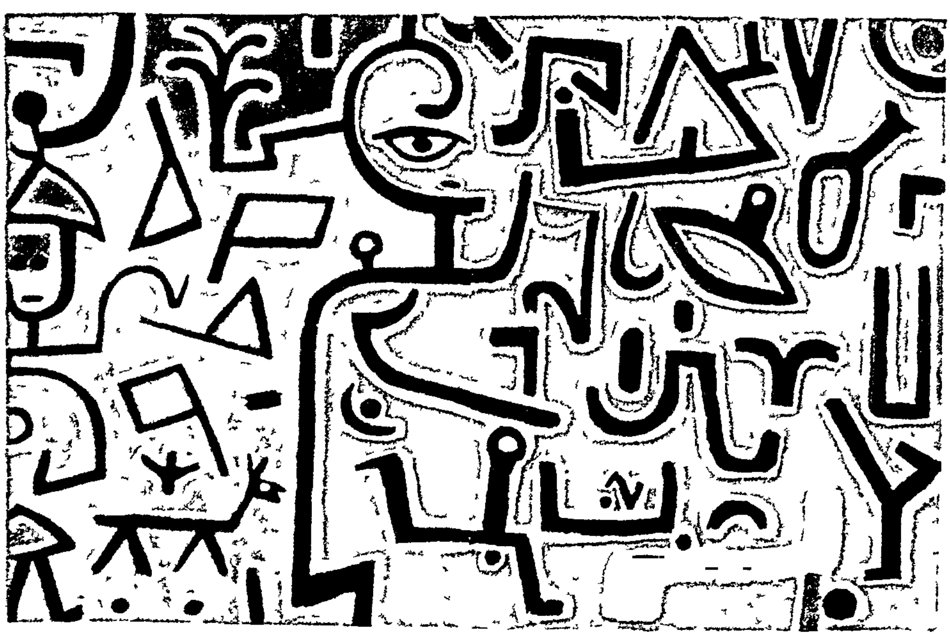
Braque, Georges (born 1881), French.
INTERIOR WITH TABLE.
1942. Oil on canvas. 84 in. x 60 in.
Hugo Gallery, New York, N. Y.

Davis, Stuart (born 1894), American.
SUMMER LANDSCAPE.
1930. Oil on canvas. 29 in. x 42 in.
Museum of Modern Art, New York, N. Y.

various objects are placed, but they are not recognizable in any photographic sense. Braque has emphasized various aspects of the objects in the picture which he thought were important. For example, he has shown us the top of the flowerpot in a generally elliptical form, but the bottom is flat. Both these facts are true, but they are not both seen in that way in a specific view. Braque, therefore, has not tied himself down to what might be seen at a particular time, but he has told us many different things about the objects and their relationships.

'Intention', by Paul Klee (*klā*), does not draw upon recognizable subject matter. It is a picture of a thought process. Klee has given us an idea of what an intention might be composed. Slightly to the left of the center is a simplified outline of a body and in the head at the top is a single eye. A large number of forms surround it, signifying the thoughts which might go to make up an intention. Many are easily identified—a tree, an animal, several figures. Others are vague, and the simple forms might be interpreted in many ways. Some of these are shown by themselves, but some are joined to other forms. All are edged in lighter colors.

The background is a clear brick red on one side; on the other side it is dull green. Perhaps the painter is saying that some thoughts are sharp and clearly remembered; others are dim and vague. Whatever we make of the picture, we are fascinated by the rich, varied pattern and the wealth of interesting forms.



Klee, Paul (1879–1940), Swiss.
INTENTION.
1938.
Oil on newspaper over canvas.
Klee-Stiftung, Berne, Switzerland.

Floral offerings for the god, Mentu
XIX Dynasty.
Copy of a wall painting from the tomb of User-Het. Thebes, Egypt.
Metropolitan Museum of Art, New York, N.Y.

Portrait panel. Egypto-Roman.
2d century A.D. Encaustic on wood. 15 in. high.
From El Fayum.
Metropolitan Museum of Art, New York, N. Y.

As we review the history of painting we will see other examples of subject matter and technique.

Painting in Ancient and Medieval Times

The Cro-Magnon peoples of prehistoric times were highly developed artists. On the walls and ceilings of several caves in Spain and southern France have been found remarkable paintings of the animals upon which the food supply of the cave man depended. They are drawn with a sensitivity and accuracy that have seldom been equaled in the history of art (*see* Drawing; Man). The cave man probably believed that picturing animals so realistically gave him a magic control over them and promised success in hunting.

Egypt produced a great civilization three thousand years before the Christian Era (*see* Egypt, Ancient). Its tombs and temples were ornamented with paintings of great distinction. Shown above, left, is a painting from a tomb at Thebes. It shows floral offerings being made to the hawk god, Mentu. In contrast to the realistic drawings of the cave men thousands of years earlier, this is highly stylized. Yet the figures are drawn with great delicacy and refinement. Repeating the figures and plants gives a feeling of rhythm. The many variations among the figures give subtlety and richness.

Very little painting has survived from the classical age of Greece and Rome. The decorated vases of the Greeks and wall paintings from Pompeii and Herculaneum are among the few remains (*see* Greece; Greek and Roman Art). Some of the best examples of classical painting come from Egypt. The portrait above, right, is from a tomb. At the time it was made (2d century A.D.) Egypt was being ruled by Rome, but the artist who painted the portrait was a Greek. It is a realistic painting, done with simplicity and power.

Christianity spread slowly throughout the Western world, becoming the official religion of the Roman Empire in the 4th century. By that time, however, the empire was falling apart and the capital was moved to Byzantium. There a stiff and formal style of art, called Byzantine, developed and lasted for hundreds of years. Examples of it may be seen in Istanbul and in some Italian cities, particularly Ravenna, which for a time was the capital of the Byzantine empire in Italy (*see* Ravenna).

During the Middle Ages, which extended from about the year 500 to about 1500, the church was the only stable institution in Western Europe. The monasteries alone kept culture and learning alive. Many of the monks were fine artists and craftsmen. The manuscripts which they copied and decorated are the most beautiful examples of art of the period. They are called *illuminated manuscripts* (*see* Books).

Beginning with the 12th century, life became more secure. Towns grew and trade and industry prospered. These towns became centers not only of wealth but of art and learning as well. In northern Europe a style of art developed which we call *Gothic*. It is best known for its magnificent cathedrals (*see* Cathedral). The stained-glass windows are the glory of the cathedrals. They are really paintings in glass (*see* Glass).

Late Italian Gothic Painting

The rise of town life brought with it a spirit of inquiry and invention. Men questioned ideas that had been held for centuries. New ways of living demanded new solutions. The painting by Giovanni Cimabue (*chē-ma-bọ′ā*), 'The Madonna of the Angels', is especially interesting because it shows some of the characteristics of the Byzantine style, which had been accepted for many centuries, and the beginnings of a search for new solutions to the problems of painting.

In this painting we see Mary and the Infant Jesus on a throne surrounded by angels. The composition is stilted and symmetrical, the figures stylized and

impersonal. We may have some difficulty in accepting a painting of people who look so unlifelike. We must remember, however, that the early artists were aware that they were painting not flesh and blood people such as those we see about us every day but divine creatures of heaven. Divinities were therefore presented as magnificent and aloof. If, however, this is compared with earlier paintings in the Byzantine style, we can see that Cimabue has already departed noticeably from the tradition of the time. In spite of their coldness the figures are beginning to take on human characteristics.

The Italian Giotto (*ĝôt'tō*) was the artist who made the great break with Byzantine tradition. He was enormously popular during his lifetime and was considered one of the greatest artists who had ever lived. Even today Giotto is regarded highly. (*See* Giotto.)

'The Descent from the Cross' is one of his finest works. This scene is one of a series on the life of Jesus Christ and the Virgin Mary which he did in a small chapel in the city of Padua. It deals with the grief of Christ's mother and His followers after He had been lowered from the cross. Giotto has introduced human feeling and emotion into painting. These are real people overpowered by grief. He has conveyed the in-

Cimabue, Giovanni, real name Cenni di Pepo (1240–1302?), Italian.
THE MADONNA OF THE ANGELS.
Last quarter, 13th century.
Tempera on wood. 166⅞ in. x 108⅝ in.
Louvre, Paris, France.

Giotto di Bondone (1266?–1337), Italian.
THE DESCENT FROM THE CROSS.
1304–6 Fresco. 91 in x 97¼ in
Arena Chapel, Padua, Italy.

Eyck, Jan van (1390?–1441), Flemish.
THE MARRIAGE OF GIOVANNI ARNOLFINI AND GIOVANNA CENAMI.
1434. Oil on wood
$32\frac{1}{4}$ in. x $23\frac{1}{2}$ in.
National Gallery, London, England.

tensity of their emotions not only by facial expressions but by postures and gestures. This is a painting filled with the drama of life in terms which everyone can understand.

Giotto was not immediately followed by any artist of equal ability, and there was little development in Italian painting for almost a century. We must go to the north of Europe for the next important step.

Late Gothic Painting in Flanders

In Flanders, two brothers, Jan and Hubert van Eyck (*īk*), were working during the first part of the 15th century. They were the first to make use of *atmosphere* in their paintings The picture 'The Marriage of Giovanni Arnolfini and Giovanna Cenami' is by Jan, the more famous of the brothers. This little picture is one of the earliest to give us the feeling that the figures are standing in space surrounded by light and air. The light, coming from the left, brightens up and falls softly on the whole scene. There are high tones and shadows. Forms change from light to dark as they turn away from the glow.

We are aware of different materials—fur, metal, cloth, glass—and the way in which light is absorbed or reflected by each to show their particular qualities The details of the picture are remarkable—the slippers on the floor, the oranges on the window sill and chest, the chandelier, and the reflection of the couple and the open window in the convex mirror at the rear of the room.

Van Eyck put in these details because they had meaning for the picture. The portrait of the newly married couple is actually a record of the wedding done by the artist, who was present at the ceremony. He has told us that in the inscription with his signa-

ture on the rear wall. St. Margaret, whose carved figure appears on the bedpost, is the patron saint of newly married women. The little dog in the foreground is a symbol of wifely faithfulness. The hand of Giovanni Arnolfini is raised in a gesture of an oath of fidelity.

The Van Eyck brothers were the first artists to employ effectively a then little-used medium, oil paint. Heretofore, artists had worked almost entirely in tempera, as did Cimabue in 'The Madonna of the Angels', or in fresco, as did Giotto in 'The Descent from the Cross'. (The materials of painting are discussed in a later section of this article.) Oil paints made possible a much greater range of effects. Not only was it possible to render objects with more detail but the colors themselves had greater depth and brilliance. Knowledge of the new medium quickly spread throughout Europe and it was eagerly taken up by other artists.

Van der Weyden, Memling, and Bosch

One of the followers of the Van Eycks was Rogier van der Weyden (*vī'dĕn*). His 'Portrait of a Lady' is shown here. The important feature of the composition is the emphasis on the full, rounded face and head. In contrast, her headdress is composed almost entirely of straight lines. It forms an inverted V. The V is echoed at her neck where the major lines of the headdress are almost exactly repeated. Notice too that the fingers of the hands at the bottom of the picture also take a V shape. By contrasting the angular forms with the rounded ones, Van der Weyden has emphasized the roundness of the face. By repeating the angular form in a different size and position he added variety yet achieved unity between the parts of the picture.

One of Rogier van der Weyden's pupils was Hans Memling, whose 'Madonna and Child with Angels' is shown on the next page. In the center of the picture is the Madonna, holding the Infant Jesus with one hand and an open book with the other. The rich brocade behind her and the oriental rug on which her throne rests contrast with the simplicity of her own dress.

The Child is both of heaven and of earth. His right hand is raised in a gesture of benediction and is also an indication of childish interest in the orange which is being held toward Him by one angel. Both the angels are kneeling slightly toward the Mother and Child in a gesture of reverence, and one of them is playing music in their honor. The four figures are further related by a strong arch directly behind them, which is rich with Gothic ornamentation. Through the arch, to each side of the Virgin, we are given views out into the countryside.

Compare the treatment of this landscape with that in the painting by Giotto. Here distance and atmosphere are shown not only by accurate drawing but also by color. We know today that as objects such as hills or mountains go back into the distance they become bluer. The Van Eycks first introduced this principle in their paintings, and it was used and

Weyden, Rogier van der (1400?–1464), Flemish.
PORTRAIT OF A LADY.
About 1455. Oil on wood. 14½ in. x 10⅝ in. Mellon Collection. National Gallery of Art, Washington, D. C.

developed by the painters who followed them. This picture by Memling gives the observer a wonderful feeling of peacefulness. Here all men are at peace. Only love and harmony exist.

A great contrast to the painting by Memling is the one by Hieronymus (or Jerome) Bosch (*bŏsk*) (page 25*d*). He was a Dutch artist who lived somewhat later than Memling. His work was influenced by the Flemish school of painting. But whereas the Flemish painters created a world of serenity and reality, the world of Bosch is one of horror and imagination. His 'Vision of Tondalys' both amuses and frightens us. We see a strange animal forcing a sharp stick through a large ear. A creature with a great head stretches open its mouth to show a table with people both behind and under it. A man caught in a big hat finds that one of his legs is sprouting roots. People fly through the air. In the background fire lights up the sky.

We marvel at the extraordinary fantasy of the artist. We also feel that the man himself must have been very morbid to have been so concerned with pain. Although his pictures, with their weird animals and monsters, look as if they belong to the Middle Ages, they are not too unlike some of the paintings that are being produced today by painters who are termed *surrealists*. They too paint a world of fantasy. Bosch

Memling, Hans (1430?–1494), Flemish.
MADONNA AND CHILD WITH ANGELS.
About 1475. Oil on wood. 23⅛ in. x 18⅞ in. Mellon Collection. National Gallery of Art, Washington, D. C.

lived at a time when the medieval period was giving way to a new age. His paintings undoubtedly reflect his concern for a changing world. Looked at in this way Bosch and his fantasies are curiously up to date.

The Renaissance in Italy

The development of the Flemish school of painting during the 15th century is the brilliant end of the Gothic period. At the same time, in Italy, a new and exciting movement had sprung up. It was called the Renaissance, meaning "rebirth" (*see* Renaissance).

This was a period of exploration, invention, and discovery. Mariners sailed the seas to find new lands. Scientists studied their world and the heavens. Anatomists and artists found the human body to be a marvel of mechanics and beauty. At the same time the culture of classical antiquity was rediscovered. It was one of the most exciting periods in the history of man and of art.

The birthplace of Renaissance art was Florence. There a young painter named Masaccio (*mä-zät'chō*) introduced many bold new ideas into painting. 'The Tribute Money' is a fresco done by him in a chapel in Florence. Here we see the figures of Christ, the disciples, and the tax collector all composed in an

Bosch, Hieronymus van Aeken (1450?–1516), Dutch.
VISION OF TONDALYS.
1485–95. Oil on wood.
21 in. x 28½ in.
Denver Art Museum, Denver, Colo.

area to conform to the wall surface on which the picture is painted.

Like Giotto, Masaccio gave his pictures a monumental quality, but he was more interested than Giotto in making his people human. All his figures look different from one another. Masaccio had learned a great deal about drawing the human figure. Notice the solidity of the figure of the tax collector (back to the spectator). Although the bodies of the other figures in the composition are not as clear, we are aware of muscles and bones and movement. The background shows his sense of space in treating landscapes. The near hill is dark in value and brownish in color. The ones behind are lighter in value and bluish, which make them appear to go back in the picture. The work of Masaccio represents a great stride forward in the problem of representing the visual world in painting.

'The Battle of San Romano' (next page) is by another Florentine, Paolo Uccello (*ot-chĕl'lō*), who was working at the same time as Masaccio. Uccello was a mathematician as well as an artist. He was more interested in the mechanical and scientific problems of painting than in the human and psychological problems.

Masaccio, real name Tommaso Guidi (1401–1428?), Italian.
THE TRIBUTE MONEY.
1427. Fresco. 8 ft. 4 in. high.
Brancacci Chapel, Church of the Carmine, Florence, Italy.

Uccello, Paolo, real name Paolo di Dono (1397–1475), Italian.
THE BATTLE OF SAN ROMANO.
About 1457. Tempera on wood. 81 in. x 126 in. National Gallery, London, England.

This painting, done about 1457 to celebrate the victory of Florence over Siena some 25 years earlier, is a study in perspective. Uccello has drawn the figures of men and horses in a great variety of positions in order to test his knowledge of perspective and anatomy. In the foreground are broken lances and spears, all arranged to make the ground on which the battle is being fought seem flat and real.

In the left foreground we see a fallen figure lying with his feet toward the front of the picture, his head away from the observer. Artists in describing such positions refer to them as "foreshortened." Although we know that a human body is several times higher than it is wide, in views such as this the width of the body is as great as the height. To draw a drastically foreshortened figure convincingly is difficult. That Uccello set himself this problem shows the interest in discovering the laws of drawing at the time.

The background is also a study in perspective, with roads, fields, and hill going back into the distance. No use has been made of atmosphere. Only lines are used to show distance. Uccello's battle does not seem very ferocious or his figures and animals very real. Yet his work was revolutionary in the discoveries that were made about the visual world.

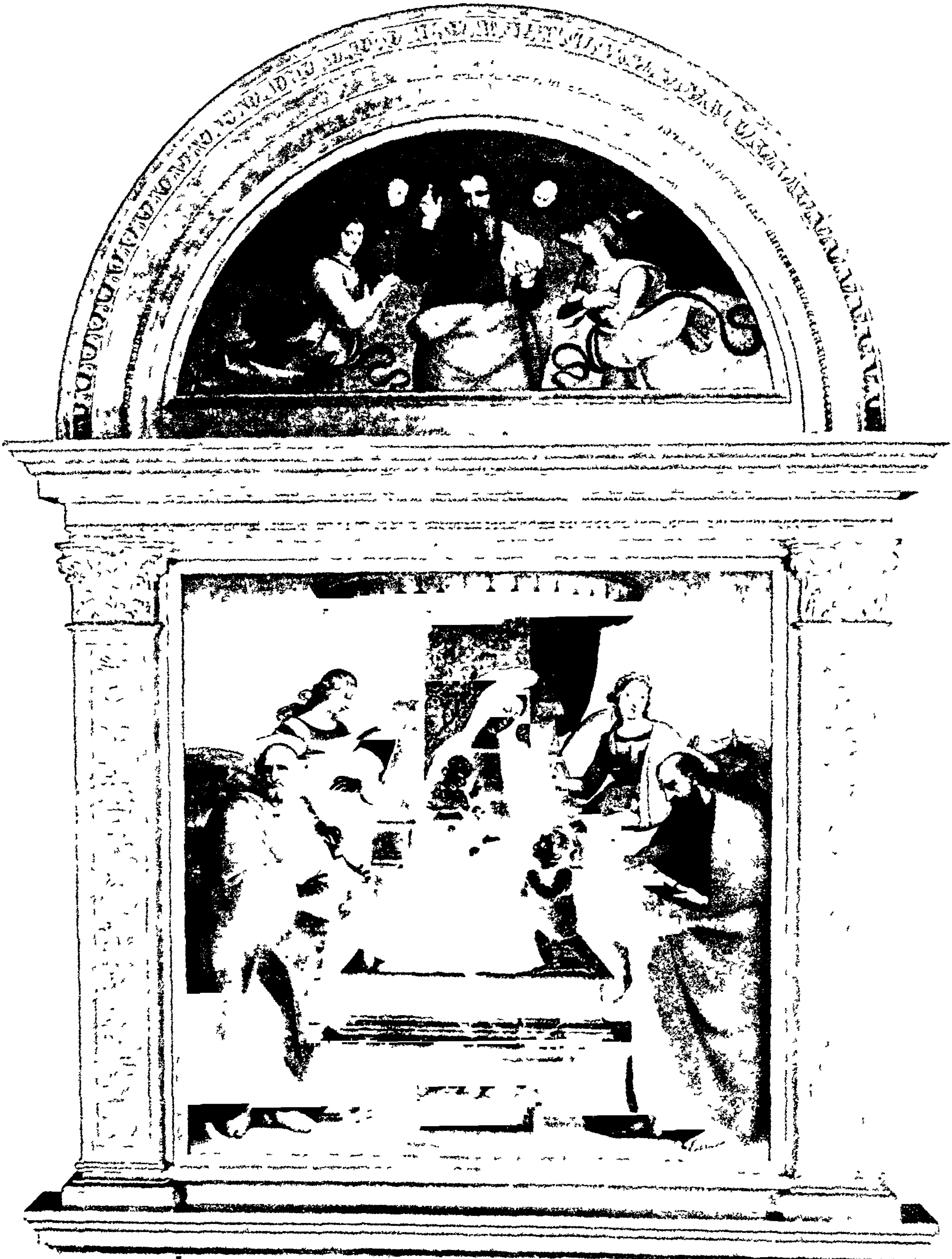
The work of such men as Masaccio and Uccello characterized the period of the early Renaissance. Botticelli, an example of whose work we have already seen (page 21), was active during the last part of the 15th century. About the beginning of the 16th century we enter a period known as the High Renaissance. It was not only an exciting time but a troubled one. Discoveries in science were changing man's ideas about himself. The Reformation, begun in Germany, had split the Christian world. The growth of wealth and the discovery of new lands had set off a struggle for power, and many wars resulted. The challenges which the age presented acted as a spur to a group of brilliant artists. They produced works at which the world will always marvel.

Raphael and Da Vinci

Raphael (*răf'ā-ĕl*) was a man of sunny and genial disposition who in his paintings created a world of nobility and harmony. He is especially known for his paintings of the Madonna and Child. Our concept of the Mother of Jesus is largely based on the type which Raphael created. 'The Madonna and Child Enthroned with Saints' is one of his early works, but it shows many characteristics for which he is famous.

We are aware of a harmony that runs through it. We feel this harmony in the arrangement and in the sweetness and tranquillity of the figures. Grace and nobility are seen in every line and movement. The color is rich. A complex pattern of movement is built up and skillfully handled through the attitudes and gestures of the figures and the lines of their clothing.

The composition has great stability. The figures of the Madonna and Child and the infant John form a triangle, the general lines of which are continued downward in the steps below the throne. The two saints on either side also repeat this triangular shape. Compositions based upon a triangular form were developed during the Renaissance and are especially satisfying because of their stability. (*See* Raphael.)



Raphael, real name Raffaello Sanzio, or Santi (1483–1520), Italian.
THE MADONNA AND CHILD ENTHRONED WITH SAINTS.
About 1505. Tempera and oil on wood. Main panel 66⅝ in. x 66¾ in. Metropolitan Museum of Art, New York, N. Y.

Vinci, Leonardo da (1452–1519), Italian.
MONA LISA.
About 1505. Oil on wood. $30\frac{1}{4}$ in. x $20\frac{7}{8}$ in Louvre, Paris, France.

Michelangelo Buonarroti (1475–1564), Italian.
JEREMIAH.
1509–12. Fresco.
Sistine Chapel, Vatican, Rome.

No more versatile man has ever lived than Leonardo da Vinci (*vēn'chē*). He was not only one of the greatest artists of all time but an engineer and scientist as well. The 'Mona Lisa', the portrait of a woman referred to as La Gioconda (meaning "the smiling woman"), is perhaps his best-known work. Ever since it was painted it has captured people by its haunting and compelling qualities. (*See* Vinci.)

It is said that La Gioconda had been saddened by the death of her child and that Leonardo had music played to induce the wan smile which he portrayed. The figure is posed in a generally triangular form, the head at the apex. It is in front of a landscape which goes back into the distance. Da Vinci is a complete master of drawing and shading. All the forms are made with the greatest subtlety. Always trying new things, he used an unusual kind of pigment in the picture. As a result it has changed color. The painting is considerably darker than when he painted it.

Michelangelo, Titian, and Veronese

The greatest artist of the Renaissance was Michelangelo (*mī-kĕl-ăn'gĕ-lō*). Though he considered himself chiefly a sculptor, he left us equally great works as a painter and as an architect. Their power and grandeur have never been surpassed. (*See* Michelangelo.)

His masterpiece is a huge fresco covering the ceiling, some 10,000 square feet in area, of the Sistine Chapel in the Vatican. One of the figures, that of the prophet Jeremiah, is reproduced here. He is seated in a relaxed and thoughtful pose against a painted architectural background which serves as a kind of frame. The huge figure is drawn with tremendous power. He is lost in thought about his vision. Michelangelo's figures seem almost to spring from the walls on which they are painted. As no other artist has ever done, Michelangelo has shown us the greatness and the nobility of man and his tragedy too.

In the north of Italy, the city-state of Venice had become rich and powerful. Influenced by the Orient with which it traded, Venice was a city of color, luxuriousness, and pageantry. It was only logical that painting there should reflect these traits. Most famous of its gifted and brilliant artists was Titian (*tĭsh'ȧn*). He was notable chiefly for his portraits, and 'A Venetian Nobleman' is one of his finest. The painter is

Titian, or Tiziano Vecellio (1477–1576), Italian.
A VENETIAN NOBLEMAN.
Oil on canvas. 47½ in. x 36½ in.
Metropolitan Museum of Art, New York, N. Y.

Veronese, Paolo, real name Paolo Cagliari (1528–1588), Italian.
THE FINDING OF MOSES.
About 1570. Oil on canvas. 17¾ in. x 22¾ in. Mellon Collection. National Gallery of Art, Washington, D. C.

supremely skillful in catching the personality of this noble citizen. (*See* Titian.)

Another great Venetian was Paolo Veronese (*vā-rō-nā'sā*). In 'The Finding of Moses' he gives a well-known Old Testament story unusual treatment. The people who have found the infant Moses in the picture are not the ancient Egyptians we expect them to be, but men and women of 17th-century Venice. The subject is taken from the Bible, and so it is something of a shock to find the daughter of the pharaoh in the rich clothing of a Renaissance lady. Such treatment of religious themes was not unusual during the Renaissance, although it seems strange to us now. Veronese was interested in the arrangement of figures into well-composed groups, in the treatment of air and space, in the painting of rich and luxurious materials. The subjects became merely a means to that end.

The Renaissance in Germany

In the north, in Germany, the painter Albrecht Dürer (*dü'rẽr*) was influenced by the oil painting technique developed by the medieval Flemish school and by the ideas of the Renaissance, which he studied on a visit to Italy. Both these influences can be seen in the large panels of the 'Four Apostles', a painting of Saints John, Peter, Paul, and Mark. In their monumental character they show their Italian influence, yet

Dürer, Albrecht (1471–1528), German.
FOUR APOSTLES.
1526. Oil-tempera on wood. 85 in. x 30 in.
Alte Pinakothek, Munich, Germany.

the attention to detail and the handling of the paint stem from the Flemish tradition. Dürer was a magnificent draftsman. Note the impressively simple handling of the draperies which contrasts with the realistic and detailed portrayal of the heads. (*See* Dürer.)

Hans Holbein (*hōl'bīn*), born 26 years later than Dürer, is noted chiefly for his portraits. He worked in Germany and Switzerland, and in England, where he became court painter to Henry VIII. After the death of the king's third wife, Jane Seymour, his advisers proposed the German princess Anne of Cleves for his new wife. Holbein was sent abroad to paint her picture. It is a magnificent though unflattering portrait. She was neither a handsome nor a pretty person, and Holbein did not try to make her so. Her robe is richly painted, and the red and gold give the picture an allover warmth. The picture depends even more on its design for its effectiveness. The roundness of the face is emphasized by the repetitions of its form in such things as the beads and the position of the arms. In contrast, the straighter lines of the jeweled strips lead the eyes to the face. (*See* Holbein.)

Two Spanish Painters

With its conquest of the New World, Spain became one of the most powerful countries in Europe. It was to this country that the Greek painter Domenico Theotocópuli, usually called El Greco (*ĕl grĕk'ō*), journeyed in 1575. There he remained for the rest of his life. He had studied for awhile in Venice, and his style somewhat recalls the Venetian masters. El Greco, however, was an individualist, and his paintings bear his unmistakable stamp.

'The Assumption of the Virgin' (next page) was painted shortly after he arrived in Spain and shows many of the characteristics of his style. His figures are made slim to give them a spiritual, ascetic appearance. His treatment of draperies, with a heavy emphasis on light and dark, and his nervous, flamelike forms give emotional feeling to his paintings.

While El Greco was still alive, Velasquez (*vā-las'kāth*) was born. He became the painter to the court of Spain. Most of his time was devoted to painting

Holbein, Hans, the Younger (1497–1543), German.
ANNE OF CLEVES.
1539. Oil-tempera on parchment. $25\frac{5}{8}$ in. x $18\frac{7}{8}$ in.
Louvre, Paris, France.

El Greco, real name Domenico Theotocópuli (1541?–1614), Spanish
THE ASSUMPTION OF THE VIRGIN
1577. Oil on canvas 158 in x 90 in. Art Institute of Chicago, Chicago, Ill

Velasquez, Diego Rodríguez de Silva y (1599–1660), Spanish.
THE MAIDS OF HONOR.
1656. Oil on canvas. 125¼ in. x 108¾ in.
Museum of the Prado, Madrid, Spain.

stylized court patterns. His best work was that which he did on his own, such as 'The Maids of Honor'. It shows Velasquez at the left working on a large painting. In the center is the young princess Margarita with her playmates and maids of honor. In the mirror at the rear can be seen the faces of the king and queen, who have just entered and are viewing the scene. This is an informal and intimate portrayal. It shows his wonderful handling of light reflected with varying intensities from the different figures, emphasizing the forms and textures. (*See* Velasquez.)

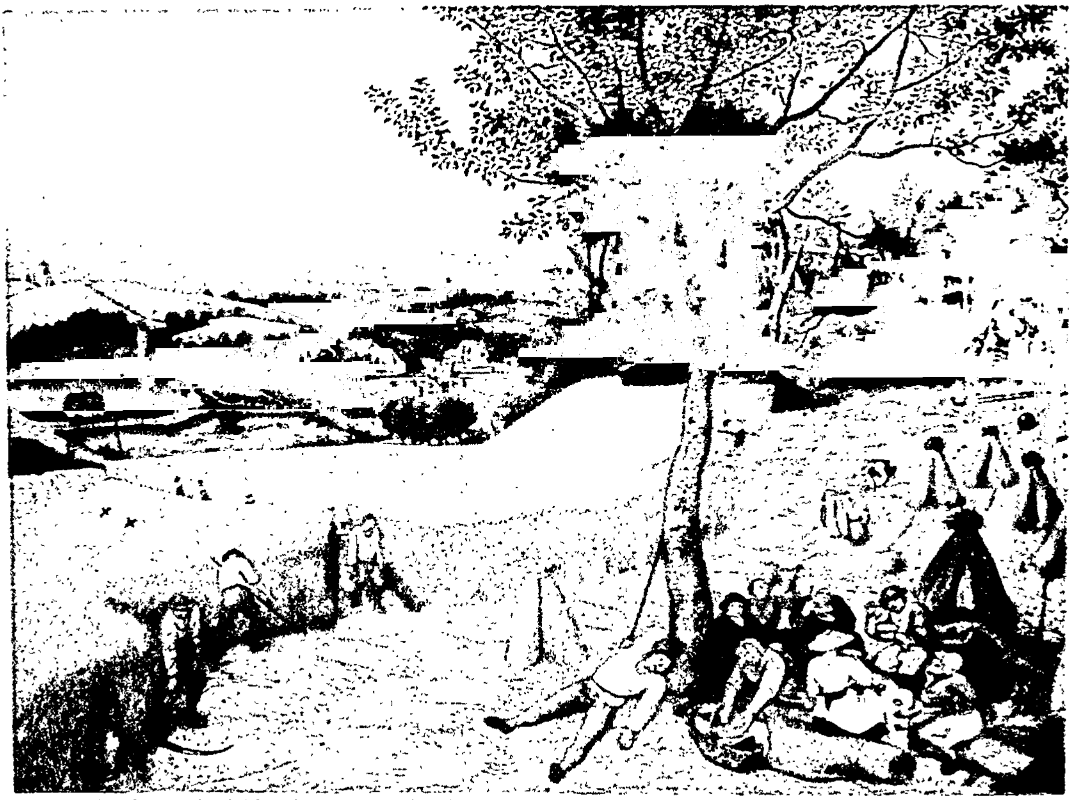
Brueghel and Rubens

Two Flemish artists, working in the 16th and 17th centuries, show us new interests and developments in painting. Pieter Brueghel (*brū'gēl*), like many of the northern painters of his day, traveled to Italy as a youth to study the works of the Italian masters. Although landscapes had been used by many artists as backgrounds, Brueghel was one of the first to make them the major feature of his pictures. In 'The Harvesters' (next page) the figures of the workers eating and resting from toil are painted with precise detail. Notice how the diagonal line of the standing grain separates foreground from background; how the figures in the right foreground are balanced by the valley and rising hills in the left background.

'The Wolf and Fox Hunt' (next page) was painted by Peter Paul Rubens about 50 years later than 'The Harvesters'. Unlike Brueghel, who showed everyday activities of ordinary people, Rubens has portrayed a moment of great excitement in a sport of noble and wealthy people. The hunters and dogs have closed in on the wolves and foxes, and the hunt is at its climax. Rubens has shown this by the rearing horses, the lunging figures of the men with the hunting spears, the snarling and biting dogs, wolves, and foxes. The sense of effort and excitement is shown even more by the composition. All the figures and animals are arranged in two sets of opposing diagonals. Compare this with the restfulness and solidity of the triangular compositions of Da Vinci and Raphael. Diagonals express movement and energy. Rubens, like all great artists, made use of those forms and colors which carry the ideas he was trying to express. He was the greatest artist of his day. His paintings overflow with energy and excitement. (*See* Rubens.)

The Dutch School

In the 17th century, Holland and Flanders, then known as the Spanish Netherlands, freed themselves from the control of Spain, and the Dutch established an independent nation. They were Protestant, while the Flemish remained Roman Catholic. Flemish art continued to serve the church in paintings of religious subjects to adorn altarpieces and chapels. The Protestants did not believe in decorating their churches with works of art. They were very proud, however, of



Brueghel, Pieter, the Elder (1525?–1569), Flemish.
THE HARVESTERS.
1565. Oil on wood. 46½ in. x 63¼ in. Metropolitan Museum of Art, New York, N. Y.

Rubens, Peter Paul (1577–1640), Flemish.
THE WOLF AND FOX HUNT.
About 1617. Oil on canvas. 96 in. x 148½ in. Metropolitan Museum of Art, New York, N. Y.

Rembrandt Harmenszoon van Rijn (1606–1669), Dutch.
YOUNG GIRL AT AN OPEN HALF-DOOR.
1645. Oil on canvas. $40\frac{3}{4}$ in. x $34\frac{1}{8}$ in.
Art Institute of Chicago, Chicago, Ill.

the country they had won at the cost of so much blood and suffering. As they prospered, the rich burghers indulged in the luxury of portraits of themselves and their wives and pictures to hang in their homes.

These paintings showed the beautiful Dutch countryside, charming village streets and houses, the interiors of homes and taverns, and simple people engaged in everyday duties and pleasures. The pictures were small in scale. Except for a few commissioned to hang in guildhalls and town halls, they were intended to ornament the private home.

Holland was full of painters and art collectors. Good paintings were so numerous and so cheap that the artists themselves lived in poverty. Frans Hals and Van Ruisdael died in a poorhouse. Vermeer and Rembrandt were bankrupt at the end of their lives.

Some Masters of the Dutch School

Frans Hals (*häls*) in his painting 'The Gypsy Girl' gives us a good idea of the vigor and love of life of the Dutch people. His painting is not "finished" like that of artists before him. The paint looks as if it had been put on very quickly. This technique carries a feeling of dash and gusto rather than of refinement and dignity. Compare 'The Gypsy Girl' with Holbein's 'Anne of Cleves'. For all its truth to nature and its beauty of detail, the Holbein still looks posed. The portraits of Hals, with a few brush strokes, seem to have caught a fleeting expression—amusement, scorn, mischief—and fixed it on canvas forever. (*See* Hals.)

Rembrandt van Rijn (*rīn*) was the greatest artist in the Dutch school and one of the greatest artists of all time. The attractive subject of 'Young Girl at an Open Half-Door' is humble, thoughtful, and serious. It is, however, the treatment of light which chiefly attracts us. The head and left hand of the girl are bathed in a soft, glowing, and almost magical light. Behind her a dull glow silhouettes the right side of her figure. Fine changes of color tone create a deep space in which the figure is placed. No greater master of light than Rembrandt ever lived. He seems to light up not only the faces and figures of his subjects but their innermost thoughts as well. (*See* Rembrandt.)

Hals, Frans (1580?–1666), Dutch.
THE GYPSY GIRL.
About 1625. Oil on wood. $22\frac{7}{8}$ in. x $20\frac{1}{2}$ in.
Louvre, Paris, France.

Hogarth, William (1697–1764), English.
THE GRAHAM CHILDREN.
1742. Oil on canvas.
63¼ in. x 71¼ in.
Tate Gallery,
London, England.

Constable, John (1776–1837), English.
A VIEW OF SALISBURY CATHEDRAL.
1820–30. Oil on canvas.
28¾ in. x 36 in.
Mellon Collection.
National Gallery of Art,
Washington, D. C.

tion of the Stuart rulers in the 17th and early 18th centuries, people of wealth preferred to employ foreign artists. William Hogarth was among the first Englishmen to develop painting of a national character. 'The Graham Children' is a portrait of the children of wealthy parents. Yet he has avoided making a stiff and formal composition and has presented the young people with charm and wit. (*See* Hogarth.)

A generation later Sir Joshua Reynolds had become the most important member of the English portrait school. His 'Lady Elizabeth Delmé and Her Children', in contrast to Hogarth's painting, is elegant and aristocratic. (*See* Reynolds.)

The English made their greatest contribution to art in landscape painting. In such works as John Constable's 'A View of Salisbury Cathedral' and Joseph M. W. Turner's 'The Grand Canal, Venice', we see nature closely observed and studied. Notice the brilliance of light on buildings and water and the great freedom in use of color. This use of light and color was carried much further by French artists later in the 19th century. (*See* Constable; Turner.)

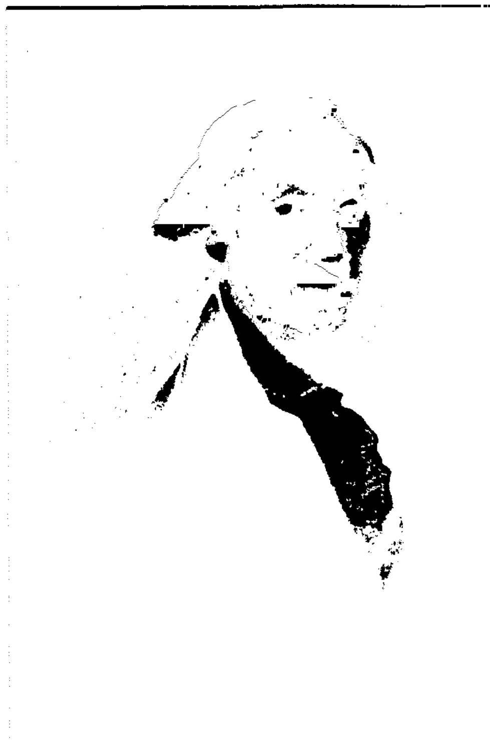
Beginnings of Painting in America

The early settlers in America were too busy establishing themselves in a new country to be very concerned with painting. Puritan severity, moreover,

Reynolds, Sir Joshua (1723–1792), English.
LADY ELIZABETH DELMÉ AND HER CHILDREN.
About 1777–80. Oil on canvas. 93¼ in. x 57¾ in.
Mellon Collection.
National Gallery of Art, Washington, D. C.

Turner, Joseph Mallord William (1775–1851), English.
THE GRAND CANAL, VENICE.
About 1835. Oil on canvas. 36 in. x 48¼ in.
Metropolitan Museum of Art, New York, N. Y.

Copley, John Singleton (1738?–1815), American.
PAUL REVERE.
About 1765–70. Oil on canvas.
$34\frac{7}{8}$ in. x $28\frac{1}{2}$ in.
Museum of Fine Arts, Boston, Mass.



Stuart, Gilbert (1755–1828), American.
GEORGE WASHINGTON,
VAUGHAN PORTRAIT.
1795. Oil on canvas. 29 in. x $23\frac{3}{4}$ in. Mellon Collection.
National Gallery of Art, Washington, D. C.

Trumbull, John (1756–1843), American.
THE BATTLE OF BUNKER'S HILL.
1786. Oil on canvas. 25 in. x 34 in. Yale University Art Gallery, New Haven, Conn.

frowned upon unnecessary luxuries. Early in the history of this country, however, portraits began to appear. Many of them were done by self-trained artists who called themselves "limners" and who went from town to town painting portraits. The interest in portraits undoubtedly developed in this country because it was still a colony of England where portraiture was flourishing and where most American artists went either to study or to live.

The portrait of Paul Revere was done several years before the Revolution by the greatest of American colonial painters, John Singleton Copley (*kŏp'lĭ*). There is no attempt at elegance or show. We see an honest, straightforward quality in the picture. The inner honesty of the men who laid the foundations of our country is clearly shown.

Gilbert Stuart is especially known for his portraits of George Washington, one of which is shown here. He painted more easily than Copley and his characterizations seem somewhat more gracious, but they lack Copley's powerful sense of structure.

It was only natural that the young United States of America should have been proud of its beginnings. John Trumbull produced a series of historical paintings of which 'The Battle of Bunker's Hill' is one. He

West, Benjamin (1738–1820), American.
COLONEL GUY JOHNSON.
About 1786. Oil on canvas $79\frac{3}{4}$ in. x $54\frac{1}{2}$ in Mellon *Collection. National Gallery of Art, Washington, D.C.*

Hicks, Edward (1780–1849), American.
THE PEACEABLE KINGDOM.
About 1833. Oil on canvas. 24 in. x $31\frac{1}{4}$ in Denver Art Museum, Denver, Colo.

Goya y Lucientes, Francisco José de (1746–1828), Spanish.
SEÑORA SABASA GARCÍA.
About 1814.
Oil on canvas. 28 in. x 23 in.
Mellon Collection.
National Gallery of Art,
Washington, D.C.

has chosen the moment of the death of General Warren. The entire picture is dramatically composed and lighted in keeping with the nature of the subject.

Benjamin West lived most of his life in England where he reached notable success. His portrait of Colonel Guy Johnson (preceding page), one of the first superintendents of Indian affairs, while somewhat self-conscious, is an authentic picture of frontier times. (*See* West.)

The paintings by these Americans were in the European tradition. The artists had been influenced by European styles or had studied abroad or both. In contrast, 'The Peaceable Kingdom' (preceding page), by Edward Hicks, a devout and self-taught Quaker, is the kind of painting termed *primitive*, because it lacks many of the devices for the handling of form and space that are found in the work of a professionally trained artist. Hicks had said that this picture interpreted the Biblical lines found in Isa. xi, 6—the lion and the lamb shall lie down together "and a little child shall lead them." The other animals mentioned in the verse are shown too, and in the distance can be seen William Penn working out his peace contract with the Indians. Hicks's painting clearly is the resul of a deep religious feeling, which he has conveyed in charming manner.

Goya and Daumier

Contemporary with these American painters was Spaniard, the greatest artist of that country sinc Velasquez. Like Velasquez, Goya (*gō'yȧ*) was a Spanish court painter whose best work was done apar from his official duties. He is known for his painting and prints of violence, especially those prompted b the French invasion of Spain. He also painted charming portraits such as 'Señora Sabasa García'.

Honoré Daumier (*dō-myā'*), a French artist, wa deeply interested in people, especially the underprivileged. In 'Third-Class Carriage' he shows us, wit great compassion, a group of people on a train journey. We are especially concerned with one famil group, the young mother tenderly holding her smal child, the weary grandmother lost in her own thoughts and the young boy fast asleep. The painting is don with simple power and economy of line. The hands for example, are reduced to mere outlines but beautifully drawn. The bodies are as solid as clay, thei

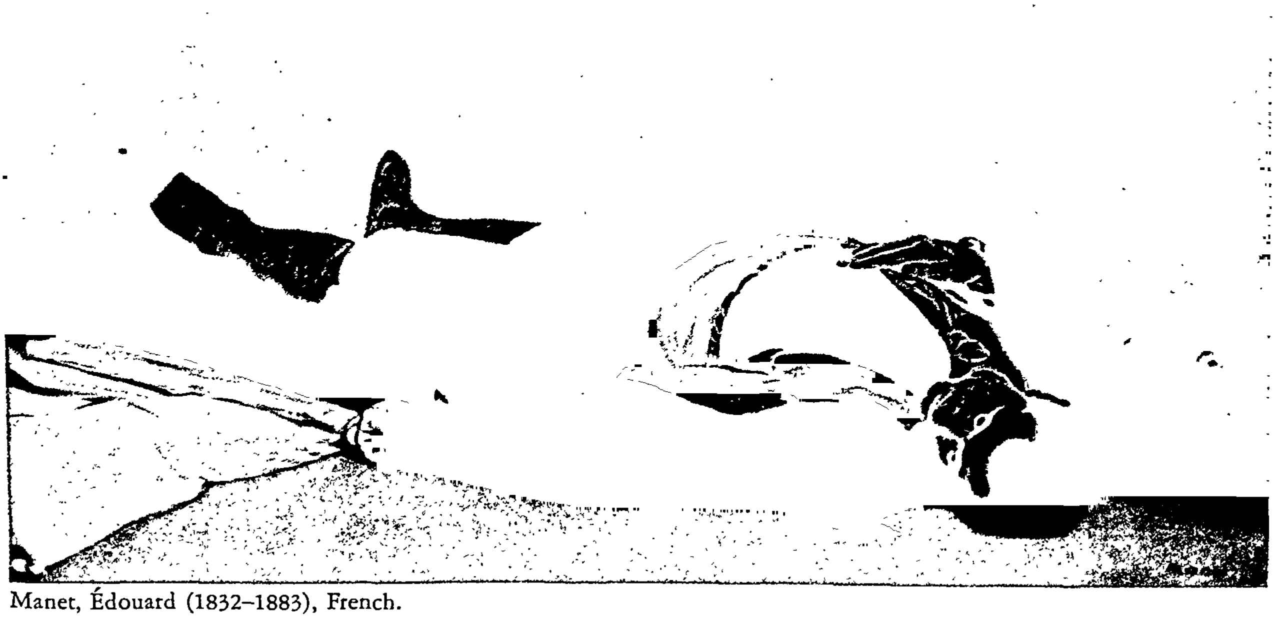
Daumier, Honoré (1808–1879), French.
THIRD-CLASS CARRIAGE.
In the 1860's.
Oil on canvas.
$25\frac{3}{4}$ in. x $35\frac{1}{2}$ in.
Metropolitan Museum of Art, New York, N. Y.

bulk indicated by stressing the essential and avoiding the nonessential. These are not portraits of particular people but of mankind.

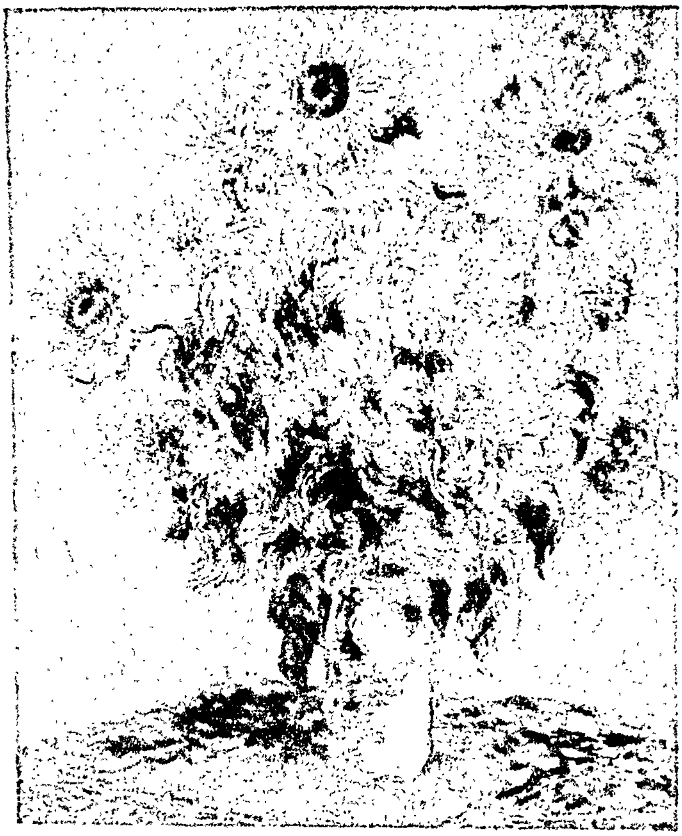
The French Impressionists

From the time that artists first used light in their paintings, they showed form through differences in values (the amount of light and dark in a color) and through modeling (the use of light and shade whereby a third-dimensional effect is achieved). A French artist, Édouard Manet (*mȧ-nĕ′*), introduced a revolutionary method of painting. Notice that in his striking painting 'The Dead Toreador' the light strikes the figure head-on. There are no shadows. Form in the painting is obtained, not with differences of value, but with different patches of color.

This idea was carried even further by artists such as Claude Monet (*mô-nĕ′*), who painted 'Sunflowers' (next page). Monet developed what is called "broken color" painting; that is, he painted objects by means of brush strokes of various colors placed next to each



Manet, Édouard (1832–1883), French.
THE DEAD TOREADOR.
1864. Oil on canvas. $29\frac{3}{4}$ in. x $60\frac{1}{2}$ in. Widener Collection. National Gallery of Art, Washington, D. C.



Monet, Claude (1840–1926), French.
SUNFLOWERS.
1881. Oil on canvas. 39¾ in. x 32 in.
Metropolitan Museum of Art, New York, N. Y.

other. Instead of mixing colors together on a palette, as artists had done for centuries, Monet and his followers put the color strokes on separately and let the eye of the observer mix them. Such paintings have a wonderful vitality and sense of light. The technique is known as *impressionism.* The word derives from a painting exhibited by Monet in 1874, entitled 'Impression: Sunrise'. Constable and Turner had suggested the use of paint to convey light. But not until the impressionists had the artist reproduced fleeting atmospheric effects so accurately.

Georges Seurat (*sû-rä'*), who is considered a postimpressionist, used the idea of broken color to develop a very characteristic style called *pointillism.* He painted entirely by means of dots of pure color. The most subtle ranges in form and color could be shown by changing the combination of colors of the dots. This was a very controlled way of painting, and the compositions of his pictures are entirely in keeping with the great care required by the method. The

Degas, Hilaire Germain Edgar (1834–1917), French.
THE BALLET CLASS.
About 1880. Oil on canvas. 32 in. x 29½ in.
Philadelphia Museum of Art, Philadelphia, Pa.

Seurat, Georges (1859–1891), French.
SUNDAY AFTERNOON ON THE ISLAND OF THE GRANDE JATTE.
About 1884. Oil on canvas. 81 in. x 120⅜ in.
Art Institute of Chicago, Chicago, Ill.

painting 'Sunday Afternoon on the Island of the Grande Jatte' is a view of a gay holiday crowd on an island near Paris. The careful composition gives the effect of great stability, which is in curious contrast to the lively effect of the dots of paint. It has a feeling of rightness and even truthfulness that make it one of the greatest of modern pictures.

In the 1860's an exhibition in Paris of Japanese prints greatly interested the impressionists. They were seeking new subject matter and new color schemes, a fresh point of view, the unexpected and the original. All these they found in the work of the Orient. Edgar Degas (*dĕ-gä'*) was one of the impressionists who found inspiration in Japanese art.

He was particularly interested in showing rhythmic movement from unusual angles. In 'The Ballet Class' the point of view is high, as though the artist were looking down from a box above the stage. In defiance of custom, he did not hesitate to cut off his figures by the frame. The awkward, sprawling figure in the foreground is very carefully designed to balance the group of dancers in the background. The line of her skirt is repeated in the dancer's uplifted leg and arms; the horizontals of the chair rungs are repeated in the back wall. He skillfully gives a feeling of movement in space.

Renoir, whose picture 'Two Little Circus Girls' we have seen (page 20), was also one of the important French artists who helped develop impressionism.

19th-Century American Painters

Europe, with its long and brilliant tradition in painting, has always exercised a fascination for American painters, and most of them have spent some time there in travel and study. Some, such as Whistler, chose to remain there, where they tended to relate themselves to European schools of painting.

James McNeill Whistler studied in Paris, but he lived in London many years. Like Degas, he was deeply influenced by Japanese prints and by the French impressionists. He was not a true impressionist, however, for his chief interest was not in effects of light and color but rather in the composition of delicate patterns. Like the impressionists, he rebelled against painting sentimental stories. He sought instead to evoke emotion with patterns of tone and color as a musician would with patterns of harmony and melody. Indeed his paintings have musical titles and subtitles—Harmonies, Nocturnes, and Arrangements. 'The White Girl: Symphony in White, No. 1' (next page) is typical, with its careful composition and its subdued colors. He is famed for his deft use of one predominant color. (*See* Whistler.)

Whistler, James Abbott McNeill (1834–1903), American.
THE WHITE GIRL:
SYMPHONY IN WHITE, NO. 1.
1862. Oil on canvas. 84½ in. x 42½ in.
Harris Whittemore Collection.
National Gallery of Art, Washington, D.C.

Other painters, returning to this country after study in Europe, developed styles which were more typically American both in subject and in treatment. Winslow Homer loved the sea and painted it in many moods (*see* Homer, Winslow). In 'Breezing Up' he has caught the feeling of liveliness that can come from sailing on a windy day. Thomas Eakins too painted those scenes with which he was very familiar. 'Between Rounds' is typical of his work. He shocked his contemporaries by his realism and his unwillingness to make his pictures "pretty." His paintings have an integrity and a solidity which make him one of the greatest artists America has produced.

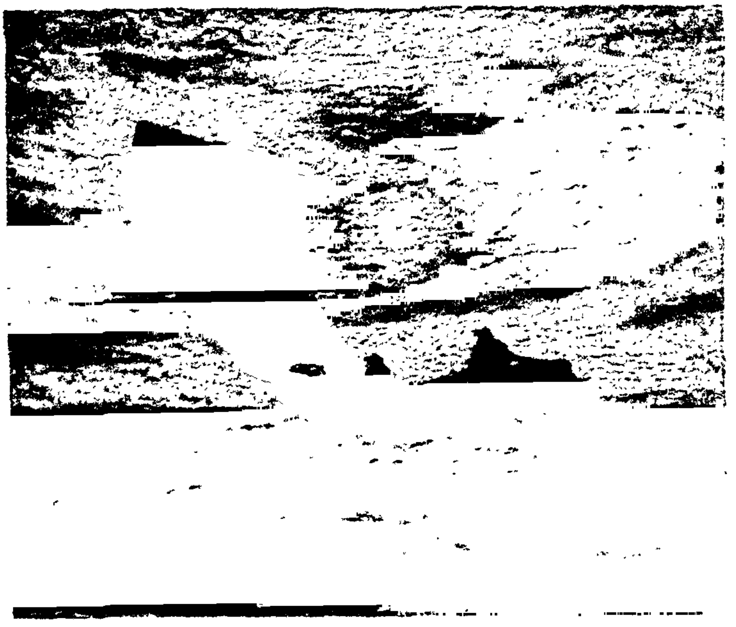
Albert Pinkham Ryder was completely different in temperament. Whereas Eakins was a realist and a scientist, Ryder was a poet and a romantic. In 'Toilers of the Sea' the forms are flat and simple, the colors few and dark, the effect poetic and mysterious. We feel the eerie light of the moon and the restless surge of the waves.

Van Gogh, Cézanne, and Modigliani

In Europe, meanwhile, other postimpressionists were making use of the discoveries of the impressionists but were carrying the movement further in various directions. One of these was Vincent van Gogh (*KÔK*), a Hollander, who in his short and troubled life left a large number of exciting paintings.

For a time he was in the service of the church, working among the poor, and the sense of compassion which he felt toward people is seen in his paintings. Whereas Seurat was interested in solidity and form, Van Gogh was interested in expression and emo-

Homer, Winslow
(1836–1910), American
BREEZING UP.
1876. Oil on canvas.
24⅛ in x 38⅛ in.
Gift of W. L. and May T.
Mellon Foundation.
National Gallery of Art,
Washington, D.C.



Ryder, Albert Pinkham (1847–1917), American.
TOILERS OF THE SEA.
Date unknown. Oil on canvas. 9¾ in. x 11¾ in.
Addison Gallery of American Art,
Phillips Academy, Andover, Mass.

Eakins, Thomas (1844–1916),
American.
BETWEEN ROUNDS.
1899. Oil on canvas. 50¼ in. x 40 in.
Philadelphia Museum of Art,
Philadelphia, Pa.

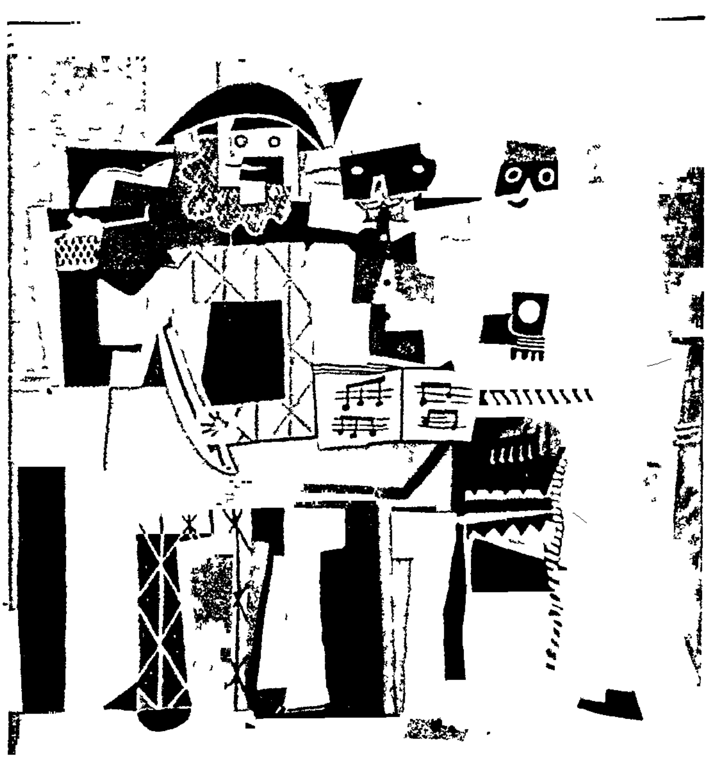
Cézanne, Paul (1839–1906), French.
PORTRAIT OF LOUIS GUILLAUME.
1879–82. Oil on canvas. 22 in. x 18¼ in.
Chester Dale Collection.
National Gallery of Art, Washington, D. C.

Modigliani, Amedeo (1884–1920), Italian.
GIRL WITH BRAIDS.
1917. Oil on canvas. 23½ in. x 17½ in.
Collection of Mr. and Mrs. Sam A. Lewison, New York, N. Y.

tion. To him, all the world was an expression of vitality and meaning. In 'Bedroom at Arles' he has painted a picture of the small room in which he stayed while he was painting in southern France. By applying the pigment so that each stroke is visible, he gives the forms a feeling of life and energy, and the room becomes transformed into a thing of vibrant wonder. (*See* Gogh.)

Paul Cézanne (*sā-zȧn'*) is often called the "father of modern painting." The impressionists had made meaningful discoveries about light, but Cézanne realized that becoming too interested in light could mean overlooking other important aspects, such as form.

In his 'Portrait of Louis Guillaume' all detail has been discarded. There is no texture in the hair and no wrinkles in the clothes. Ignoring small, unimportant surface details, Cézanne stresses the strong basic forms which underlie surface appearances.



Picasso, Pablo (born 1881), Spanish.
THREE MUSICIANS.
1921. Oil on canvas. 80 in. x 74 in.
Philadelphia Museum of Art, Philadelphia, Pa.

Gogh, Vincent van (1853–1890), Dutch.
BEDROOM AT ARLES.
1888. Oil on canvas. 29 in. x 36 in. Art Institute of Chicago, Chicago, Ill.

Cézanne has also changed the relationship of the parts of the face. One eye is higher than the other. The mouth and chin are to the right of the nose. He made these changes not because he could not draw the face accurately but because they were necessary for the effects he wanted to achieve. He believed that a picture should not be bound by the realities of the subjects. Although the changes may look strange at first, the more we study the picture the more "right" they become, because the forms in the picture have life and unity. Alterations of this sort are called "distortion." (*See* Cézanne.)

Obvious distortion is not new in the history of art. We have seen it in Egyptian and medieval work and in El Greco's 'The Assumption of the Virgin' (page 27*c*). It is used when it suits the purpose of the artist. The only judgment that can be passed on him is whether or not he succeeds in his purpose.

Matisse, Henri (born 1869), French.
PIANO LESSON.
About 1916. Oil on canvas. 96½ in. x 83¾ in.
Museum of Modern Art, New York, N. Y.

Chagall, Marc (born 1887), Russian.
I AND MY VILLAGE.
1911. Oil on canvas. 75⅝ in. x 59⅝ in.
Museum of Modern Art,
New York, N. Y.

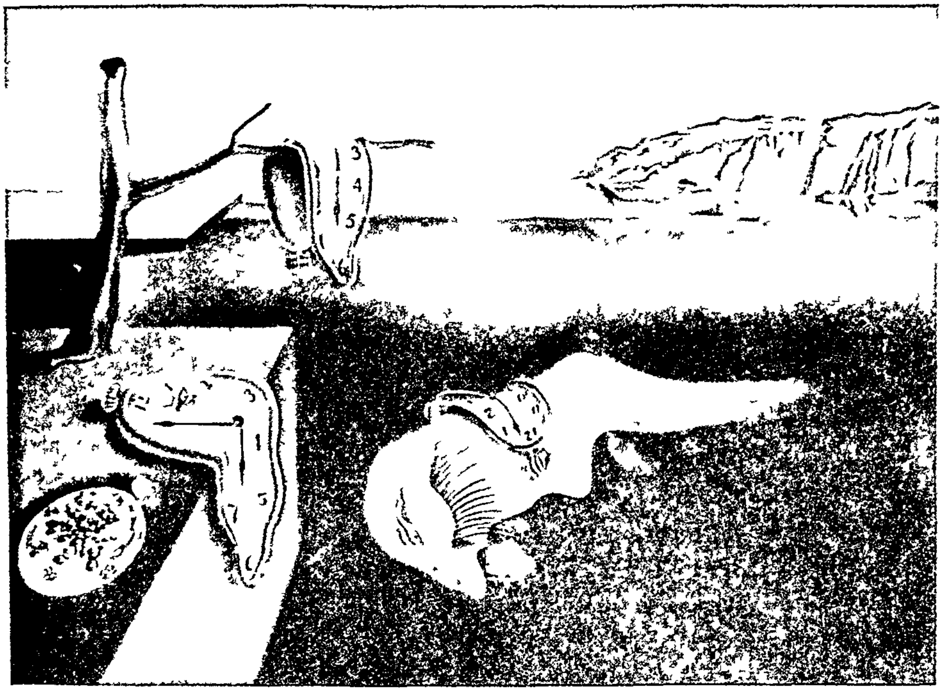
It can be seen that Amedeo Modigliani (*mō-dē-lya'-nē*) was influenced by Cézanne. In his 'Girl with Braids' (page 34) use has been made of distortion not only in the figure—notice the eyes, chin, and shoulders—but in the background as well. Yet it is an individual style, not powerful but sensitive and graceful.

Picasso, Matisse, and Chagall

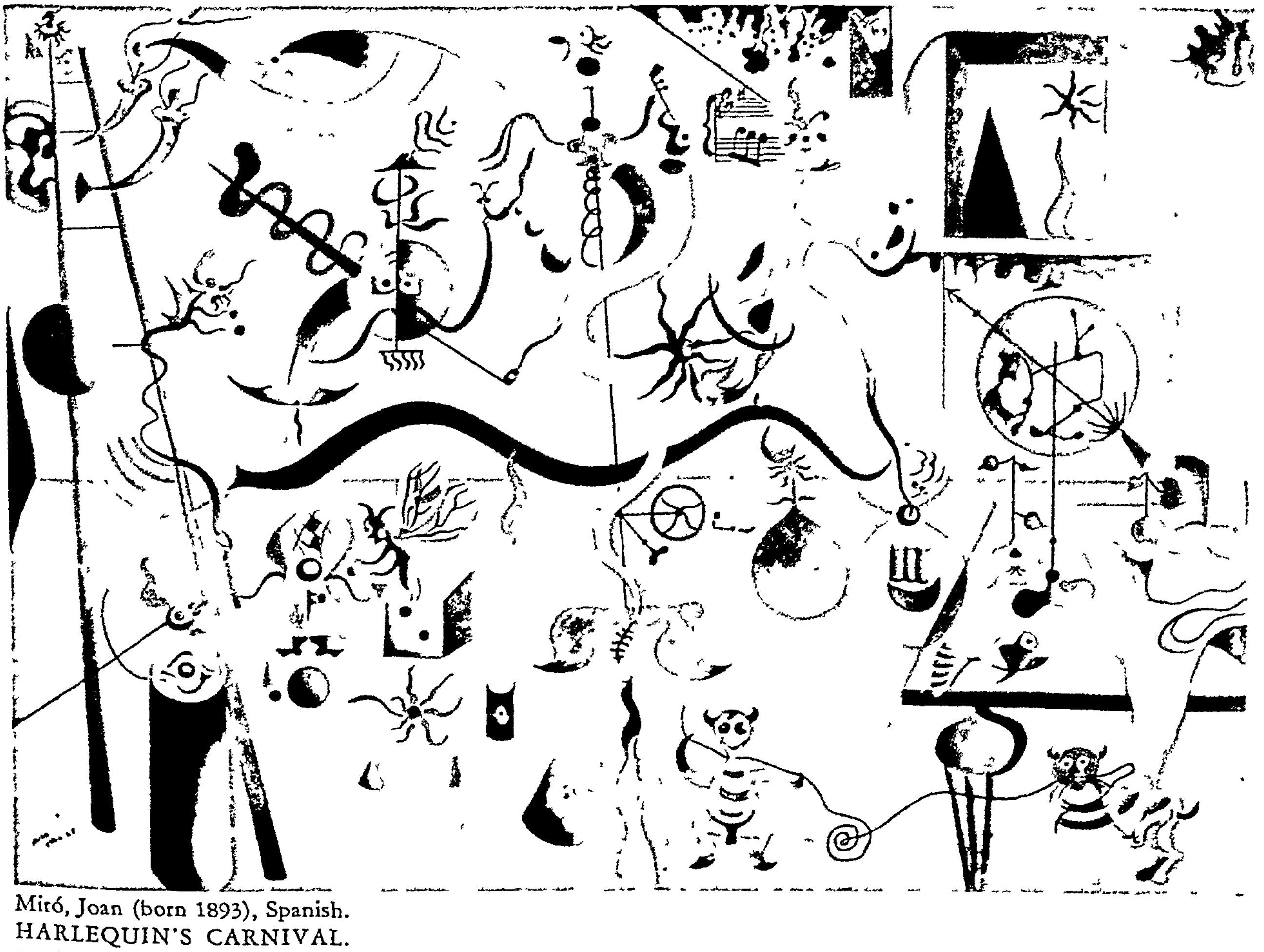
In Pablo Picasso (*pē-ka'sō*), a Spaniard who has lived most of his life in France, we find the most important painter of the 20th century to date. Hardly a painter lives today who has not been influenced by him. Extremely experimental and inventive, he has developed a series of styles, each quite different from the others and each concerned with some particular problem of painting or life.

Picasso was one of the artists who developed the kind of painting called *abstract*; that is, where only selected qualities or characteristics of the subjects are used in the finished picture. Cézanne, in emphasizing the basic shapes of the things he painted, was himself being abstract. Other artists, including Picasso, carried this idea much further. One kind of abstract painting was *cubism*. In cubism the forms of objects were reduced to their simplest fundamental shapes. 'Three Musicians' (page 34) is a cubist painting. Notice that Picasso has not only simplified the shapes that go to make up the bodies of the three figures but has rearranged them. All the shapes are flat, and form is shown not by shading or by shadows but by the placement of the flat forms in relation to and on one another. There is a wonderful feeling of relationships in this picture. The various forms are enlivened with rich texture and the total effect gives the painting compelling interest.

Henri Matisse (*mȧ-tēs'*) was influenced by cubism when he painted 'Piano Lesson' (preceding page). In the foreground is his son sitting at the piano. Behind him hangs a picture. To the left is an open casement looking out on a garden, indicated by the green area. Notice the interesting contrasts between the figures and the similarities between the window grill and the music rack. The colors are beautifully harmonious and the picture has a grave and tranquil elegance.



Dalı, Salvador
(born 1904), Spanish.
THE PERSISTENCE OF MEMORY.
1931. Oil on canvas.
10 in. x 14 in.
Museum of Modern Art,
New York, N. Y.



Miró, Joan (born 1893), Spanish.
HARLEQUIN'S CARNIVAL.
1924–25. Oil on canvas. $36\frac{5}{8}$ in. x 26 in. Albright Art Gallery, Buffalo, N. Y.

Cubism also has influenced Marc Chagall (*shü-gäl'*) in his charming fantasy 'I and My Village' (page 34*b*). He painted this chiefly to set down his memories of the Russian village in which he spent his childhood. A series of strong simple lines and forms hold the composition together and it is full of fairy-tale-like incidents.

Dali and Miro

An even more irrational picture is 'The Persistence of Memory' (preceding page), often called 'Wet Watches', by Salvador Dali (*da'lē*). It is difficult to explain why this picture has such a fascination for so many people, for at a glance it seems completely absurd. It is a type of painting called *surrealist.* This is no real world but one of dreams or even nightmares, where watches can hang over branches and be eaten by ants. Psychologists have shown us the importance of our subconscious mind and the way in which it asserts itself in dreams. No matter how fantastic they may be, dreams can be explained in terms of our experiences or desires. This is a very personal kind of painting in that the symbols probably had a special meaning for Dali. It is a universal kind of painting in that all of us recognize the world of our dreams.

Fantasy too is expressed in the picture by Joan Miró (*hwan mē-rō'*), 'Harlequin's Carnival' (preceding page). The fabulous harlequin is demonstrating his tricks for us. Even the cat and dog in the foreground are joining in the fun. Since all this excitement

Bellows, George Wesley (1882–1925), American
LADY JEAN.
1924. Oil on canvas 72 in x 36 in.
Collection of Stephen C. Clark, New York, N. Y.

Wood, Grant (1892–1942), American.
WOMAN WITH PLANT.
1929 Oil on canvas 20 in x $17\frac{1}{2}$ in
Cedar Rapids Art Association, Cedar Rapids, Iowa

Graves, Morris
(born 1910), American.
BIRD SINGING
IN THE MOONLIGHT.
1938–39. Gouache.
26¾ in. x 30⅛ in.
Museum of Modern Art,
New York, N. Y.

must be largely a matter of sight, Miró has placed a number of eyes and eyelike shapes throughout the picture. In the upper left-hand corner there is a large ear, the better to hear the music. Through a wonderful variety of forms and symbols, sprightly colors, wit and humor, Miró re-creates the gay and lively world of the harlequin.

Modern American Painters

Ever since colonial times there has been a strong tradition of realistic painting in America. George Bellows delighted in painting savagely realistic pictures of prize fights and boxing matches. He could also paint charming and tender pictures such as 'Lady Jean'. It is a portrait of his daughter dressed in one of her mother's gowns and hats. Her lovely warm coloring is emphasized by the cool blue and white dress and echoed in the warm background.

Grant Wood, who lived and worked chiefly in the Midwest, was an important figure in the establishment of a group during the 1930's who called themselves American Scene painters. Hoping to break away from the influence of European art, these men used only subjects which were typical of this country. 'Woman with Plant' is an honest portrait of Wood's mother. We are drawn at once to this elderly farm wife by the strong qualities she clearly possesses. By posing her against an orderly farm landscape, he gives the figure a symbolic dignity. The American Scene movement performed a service in calling attention to the fact that our own life and surroundings offered acceptable content for art. However, it was narrow in that it rejected work done by artists of other countries simply because it was foreign.

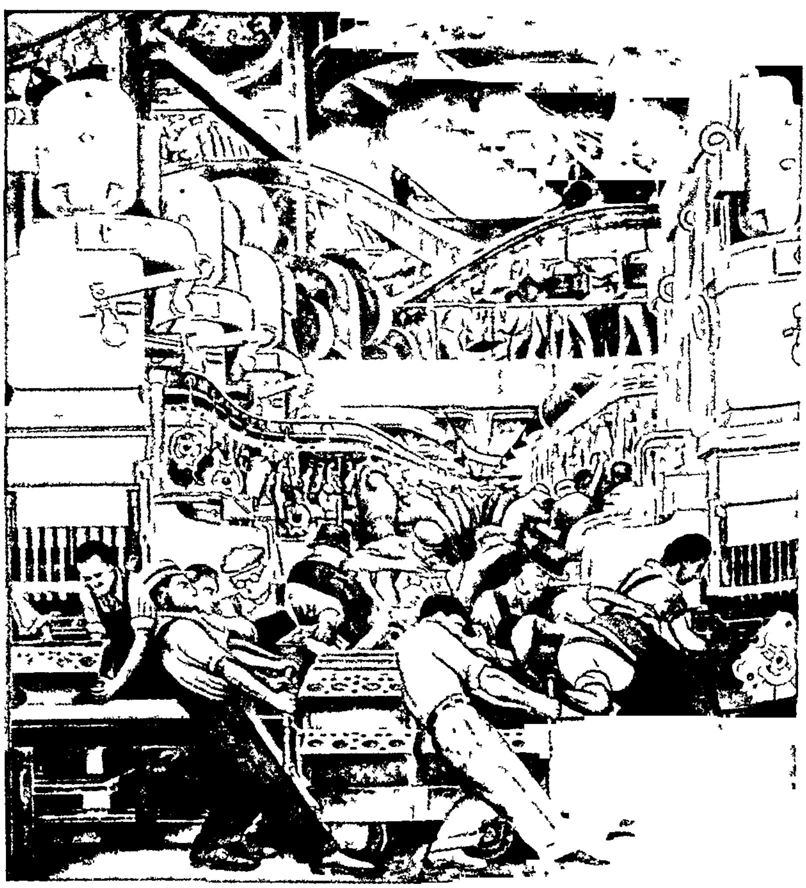
In a completely different vein is Morris Graves's 'Bird Singing in the Moonlight'. On a flat, warm, gray background recalling the depth and softness of the night, a small bird sings its song. In the picture we see, by means of a mass of fine, delicate lines, the bird literally wrapped up in its own melody. A realistic painter cannot paint a picture of a song, but a poetic and romantic one can.

The paintings by Adolf Dehn (*dān*) and John Marin (*mä'rĭn*) (pages 36, 37) strike us at once by their brilliance and freshness. This is due in part to the fact that they are painted in transparent water colors, a medium that lends itself to such effects. Both men are masters of handling water colors.

Dehn's 'Spring in Central Park' is an exciting subject. The gentle slope of the meadow, the irregular patterns of the branches and trunks of the trees, and the softness of the foliage all contrast with the geometric and regular forms of the New York sky line beyond. Nature, in a city of stone and glass, becomes an even more wonderful thing. Each sets off and adds to the special qualities of the other.

Marin, like Hartley, was fascinated with the scenery of Maine. 'Maine Islands' was done with utmost simplicity. The water and islands, as well as the plants in the foreground, are only indicated. Yet each stroke makes a wealth of impressions and suggestions. Not only do we feel the landscape stretching off into the distance, but the atmosphere of the scene also has been brought out. By means of lines at the edges of the paper, Marin has set up a series of planes that point up and add vigor to those in the landscape itself. During his lifetime Marin

Dehn, Adolf Arthur (born 1895), American
SPRING IN CENTRAL PARK.
1941. Water color $17\frac{7}{8}$ in. x $27\frac{1}{4}$ in. Metropolitan Museum of Art, New York, N. Y.



Rivera, Diego
(born 1886), Mexican.
MEN AND MACHINERY.
Completed 1933 Fresco.
One of a series of 27 panels
The Detroit Institute of Arts,
Detroit, Mich.

Marin, John (1872–1953), American.
MAINE ISLANDS.
1922. Water color. 16¾ in. x 20 in.
Phillips Gallery, Washington, D. C.

Orozco, José Clemente
(1883–1949), Mexican.
ZAPATISTAS.
1931. Oil on canvas.
45 in. x 55 in.
Museum of Modern Art,
New York, N. Y.

Portinari, Candido
(born 1903), Brazilian.
FESTIVAL, ST. JOHN'S EVE.
1938–39. Tempera on canvas.
126 in. x 138 in.
Museum of Modern Art,
New York, N. Y.

was often referred to as the greatest of American painters. Although he was influenced by European work (the planes in 'Maine Islands' are clearly cubist inspired), his paintings have a distinctively personal and American flavor.

Latin American Painters

One of the greatest of Mexican painters is Diego Rivera (*rē-vä'ra*). When he was commissioned to paint some frescoes in the courtyard of the Detroit Institute of Arts, he logically chose the automobile industry as his subjects. In 'Men and Machinery' (page 36), one of the scenes in the mural, Rivera has woven into an understandable design such forms and patterns as men, furnaces, conveyer belts, and assembly lines.

More typical of Mexican subject matter is 'Zapatistas' (preceding page), by José Clemente Orozco (*ō-rōs'kō*). Emiliano Zapata was a leader in the Mexican Revolution which made possible popular government. This is a purely national theme. The distinctly Mexican clothing, especially the forms of the hats, gives the picture a special flavor. But its artistic worth is based on the composition—the repetition of the figures of the men with their bayoneted rifles which set up an energetic pattern of diagonals; the contrast of straight and curved forms; the contrast of warm and cool colors. Orozco's figures recall Giotto's in their simplicity and solidity.

A very different but equally local theme is used by Candido Portinari (*pōr-tē-na'rē*), the Brazilian painter, in his 'Festival, St. John's Eve'. Whereas the Orozco in character with the subject is somber and determined, this is gay and lighthearted. The variety of forms, sudden contrasts between light and dark, and use of colors are planned to create the idea of festivity. The composition is basically circular. This is also important in conveying the idea of festivity.

Oriental Painting

In recent years, with the development of rapid transportation, we have become better acquainted with Oriental art. When European countries were deep in the gloom of the Middle Ages, China had developed a high level of civilization, and the arts were in full flower. 'The Tribute Horse' (page 37*c*), a painting on silk, was done during the Sung Dynasty, which extended from 960 to 1279. It shows a majestic landscape through which moves a glittering procession. Especially lighted up is the white horse which is being taken to the emperor for his service. We are impressed by the great delicacy and skill of the painting. Every stroke is applied with deep feeling for the form and texture it represents. Notice the difference between the technique used on the tree and that on the mountains. Chinese artists have always preferred nature for a subject and they have never been surpassed in their pictures of plants and land forms.

The story of Jonah and the Whale occurs in the Koran, the sacred book of the Mohammedans, as well as in the Old Testament of the Bible. It is not too much of a surprise therefore to see this famous story painted by a Persian artist (page 37*d*). Here the whale carefully sets Jonah on the bank while an

angel hastens to bring him a protective garment. The painting has a flat two-dimensional effect. Decorative in composition and rich in texture, it has a high degree of unity in the consistent use of curved lines and in the relation between the three major forms in the picture.

'Krishna Holding Mount Govardhan' (page 37*d*) illustrates a story from a great Hindu epic. Krishna had persuaded the people to worship Mount Govardhan and to worship him as the mountain god. Indra, the ancient rain-god, became angry and jealous and sent down torrents of rain. Krishna thereupon showed his supremacy over Indra by lifting the mountain with one hand, sheltering under it the people who had come to worship him. At the same time he himself is clear of the ground. This dramatic moment is represented with great richness of detail and color. It can be seen here also that Oriental artists were interested neither in perspective nor in the realistic portrayal of forms. They had other goals—beautiful and sensitive drawing, rich color, and strong composition. These are all equally valid as artistic ends and all have been used supremely well by Oriental artists.

Painting by Amateurs and Children

It is not only the famous artists who make contributions to society. Any creator, even a minor one, who discovers some truth about life and gives it expression in an art medium is helping not only himself but his audience. Tens of thousands of people are painting in their leisure time. In painting they find a creative activity which gives expression to their own ideas and emotions. Among the well-known amateur painters are such busy men as Sir Winston Churchill and Dwight D. Eisenhower.

Painting is becoming important in education. It has been discovered that children are capable of producing wonderful paintings. The two examples shown here are both straightforward and direct expressions of things the young painters knew well. It is important when anyone is painting, regardless of his age, that he be honest with himself and that the ideas he expresses be his own. This does not mean that he cannot or will not learn from other people. But parents and teachers make a mistake when they impose their ideas on young people or set up certain requirements as to how things should look.

Young people, in the development of their abilities in drawing and painting, pass through a series of stages that are related to their psychological and physiological development. Attempts to bypass these stages of development result only in making the child unhappy with his work. The freshness and vigor of approach which are natural to children become lost.

Children want sincere but not unthinking encouragement. They want help when they need it—help in giving their ideas better expression. This is a very different matter from imposing adult ideas on them.

The Materials of Painting

The kinds of materials with which an artist works are relatively few. Most important are his paints, which contain coloring matter called pigment. Most

Duncan, Margaret (14 years old).
BRENDA SPRAGG.
West Molesley County Secondary School, Surrey, England.

Grant, James (13 years old).
CHICKENS.
Dallas Independent School District, Dallas, Tex.

pigments are earth colors or minerals. Recently an increasing number are chemically produced. Each kind of paint has unique qualities and can produce some effects but not others. Thus the artist must work within the possibilities and limits of his material.

In medieval times most artists worked with tempera, as did Cimabue in 'The Madonna of the Angels' (page 25). Tempera is made with earth or mineral pigments moistened with water and then mixed with an albuminous substance such as egg white. The color is flat in surface and only slightly glossy. Because it

Master of the Sung Dynasty (960–1279), Chinese.
THE TRIBUTE HORSE.
Painting on silk. 32⅝ in. high. Metropolitan Museum of Art, New York, N. Y.

"sets" quickly it cannot be used to model or vary surfaces. Tempera is usually painted on wood covered with plaster and worked to a smooth, hard surface.

Fresco, Oils, and Water Colors

Fresco is a process of painting on wet plaster. It is especially suited to large wall surfaces. The paintings by Giotto, Michelangelo, and Rivera reproduced in this article were all done in fresco. The design of the painting is first sketched on a wall surface. At the beginning of each day's work fresh plaster is applied, on which that day's painting will be done. The sketch is redrawn on the wet plaster and the pigment is applied. In the process of drying the pigment combines with the plaster and becomes permanent. Colors in fresco, however, are somewhat limited both in brightness and in value range.

We have already learned that the Van Eyck brothers were the first to make extensive use of oil paints. Since their time oil has become the most commonly used of all mediums. The pigments are mixed with linseed oil, which allows them to spread thinly and easily. Oil paints can be made transparent or opaque so that the artist can at all times control the depth of effect. As a result, paintings in oil have a brilliance and depth not possible in any other medium.

Water colors have been in common use by Western artists for only a few hundred years. The most common type is transparent. Both Marin and Dehn used transparent water colors in their pictures shown on pages 36 and 37. As water colors are soluble in water, a great range of values is possible, from very light to very dark. Because they are transparent, the white paper on which they are usually done can show through. Brilliant effects are possible, and water colors may have a fresh and spontaneous quality.

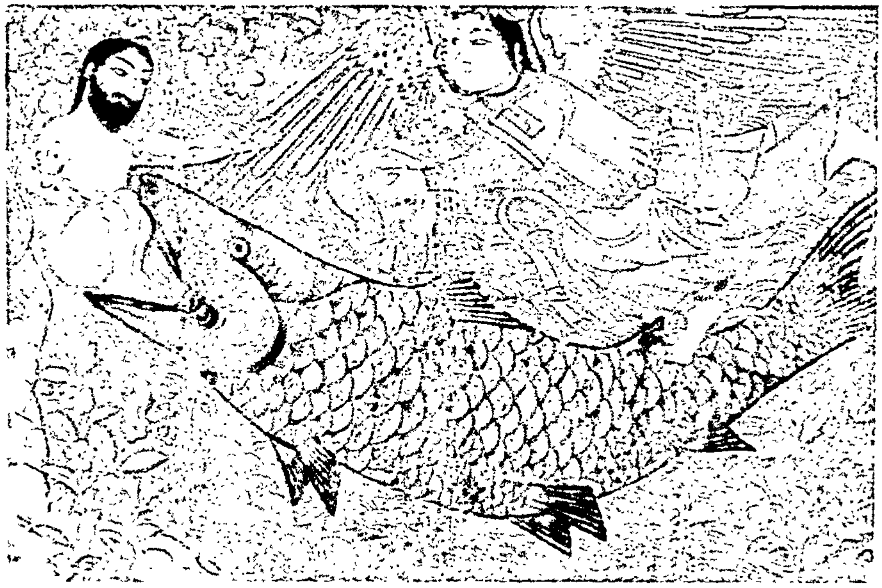
Unlike oil paintings, which can be changed and worked on over a long period of time, water colors because of their transparency are impaired or deadened when they are reworked. Gouache (*gwäsh*) and tempera are opaque water colors. They are similar in effect to the tempera already mentioned.

Where special effects are desired, painters often introduce other materials into their paintings, such as sand or bits of glass or paper. Recently, some painters have been working with enamels.

Brushes and Surfaces

Brushes are another important material of the painter. They are made of the hairs of various animals, such as sable, camel, or oxen, or from the bristles of hogs and boars. The kind and size of brush depend on the medium the painter is using and the effects he wishes to achieve. Some painters when working in oils apply the paint with a palette knife which has a thin flexible blade, rather than with a brush. Van Gogh often painted in this manner, and the effects are bold and vigorous. Paints are commonly mixed on a device called a palette. It is made of metal or wood. It is oval in shape and so designed that it can be held comfortably while the painter works.

The kind of surface on which an artist paints depends on the medium he is using. Frescoes must always be done on wet plaster. Tempera is generally



Rashid-ad-Din, Persian.
JONAH AND THE WHALE.
End of the 14th century.
Tempera on paper.
From a manuscript
of The Universal History.
$12\frac{9}{16}$ in. high.
Metropolitan Museum of Art,
New York, N. Y.

done on wood which has been given a smooth surface. The usual material for water colors is paper, which has a hard but textured surface. Oil paint can be applied to plaster, canvas, wood, or metal. The surface is treated first with white lead or other filter to provide a good working surface and to prevent the colors from sinking into the materials. (For list of terms used in painting, *see* next page.)

Conclusion

Painting is an activity that has been carried on by man since the dawn of history. Through his pictures he has left us a record of his interests, his ideals, and his aspirations. We ourselves grow in understanding and maturity when we study great paintings, for the creative minds and sensitive spirits of the masters communicate to us their own greatness.

Active participation in painting as an amateur is just as important as enjoying the work of others. It helps the individual to explore and discover the meaning of his own experiences. Working with subjects that involve feeling and values, he achieves greater emotional maturity. By giving expression to personal feelings, he develops an individuality basic to security and dignity. The basis of all painting is life itself, and an understanding of painting deepens and enriches life.

Mughal School (1556–1605), Indian.
KRISHNA HOLDING MOUNT GOVARDHAN.
Tempera on paper.
Miniature painting from a manuscript of the Mahabharata. $11\frac{1}{2}$ in. high.
Metropolitan Museum of Art, New York, N. Y.

A LIST OF TERMS USED IN PAINTING

Abstract Art: works with little or no resemblance to objects in the real world, relying for their interest and emotional impact on form and color alone; also known as *nonobjective art* or *nonrepresentational art.* Term also applied to works of art suggested by or "abstracted" from natural objects or forms. *See also* Cubism; Dadaism; De Stijl; Expressionism; Surrealism in this list.

Armory Show, The: exhibition of late 19th- and early 20th-century European paintings, held in 1913 in the 69th Regiment Armory, New York City. The first large-scale comprehensive showing of these works, it had a profound influence on the trend of American art.

Barbizon School: a group of French painters of the mid-19th century who advocated realism and a return to nature; named for the village of Barbizon in the Forest of Fontainebleau where they lived. The group included Rousseau, Corot, Bonheur, Millet, Troyon, and Daubigny.

Baroque: the florid, ornate, dramatic style current from the middle 16th to the middle 18th century. Baroque painters included the three Carraccis, Caravaggio, Guido Reni, Domenichino, and Tiepolo. In France Baroque developed into the gay *rococo* style represented by Watteau, Boucher, and Fragonard.

Byzantine: a style developed in the Byzantine Empire chiefly in the 5th and 6th centuries, combining Greek and Oriental elements; figures are rigid, solemn, and unnatural, but rich in color.

Collage: French word meaning "pasting," referring to compositions created by gluing bits of paper, cloth, and other scraps on a flat surface; parts of the picture are usually painted; used by some 20th-century painters, including Braque and Picasso.

Composition: the arrangement of forms and color in a painting to produce design, emphasis, and balance; often obeys geometric rules.

Cubism: a movement begun by Picasso and Braque in 1907, largely as a result of a statement by Cézanne, "You must see in nature the cylinder, the sphere, and the cone." Picasso and Braque took him literally. The first phase, *analytical cubism,* reduced natural forms to fundamental geometric shapes. It was followed by *simultaneity,* which gave different views of an object in the same picture, superimposed on each other.

Dadaism: a cult which developed, chiefly in Germany, after World War I; pictures were geometrical diagrams and absurd collages; Hans Arp and Max Ernst were the leaders.

De Stijl ("the style"): a Dutch movement (1917 to 1931); geometric abstractions emphasizing the use of rectangles and primary colors; influenced commercial and industrial arts. Piet Mondrian is the best-known representative.

Eight, The: a group of artists of the early 20th century, particularly interested in depicting American subjects; in 1917 organized the Society of Independent Artists; works derisively termed the *Ashcan School;* group included John Sloan, Arthur B. Davies, William J. Glackens, Robert Henri, Ernest Lawson, George Luks, Maurice Prendergast, Everett Shinn.

Expressionism: a modern movement which aims to *express* feelings, emotions, states of mind rather than to imitate visible nature. The early expressionists were *Les Fauves* ("the wild beasts"), a group of French painters who revolted against academic art and impressionism; works characterized by strong color and simplified drawing; members included Matisse, Rouault, Derain, Dufy, Vlaminck, Braque, and Segonzac.

Fresco: *see* page 37*c* in this article.

Futurism: Italian abstract painting (1911–15) concerned with "dynamic" aspects of life and the attempt to express movement by *simultaneity. See* Cubism in this list.

Genre: paintings in which subjects of everyday life are treated realistically.

Gothic: a word first used by Italian art critics of the Renaissance to denote a style they thought had been introduced by the Goths who destroyed the Roman Empire, hence barbaric. It refers today to the great cathedrals built from the 12th to the 15th century, the stained glass windows and illuminated manuscripts, and also to the pre-Renaissance painters of the period.

Hudson River School: a group of American artists of the early 19th century who painted romantic American landscapes; members were Thomas Cole, Thomas Doughty, Frederick E. Church, and Emanuel Leutze.

Impressionism: *see* page 31*c* in this article.

Naturalism: an unselective and uncritical portrayal of the physical appearance of things.

Neoclassicism: a French movement of the late 18th and early 19th centuries, founded by Jacques Louis David. It was a reaction against the luxury and elegance of the rococo period. The style imitated antique sculpture and was cold, severe, and unemotional. Heroic events and mythological characters were favorite subjects. Ingres and Prud'hon were followers of David.

Nonobjective Art: *see* Abstract Art in this list.

Oil Painting: *see* pages 37*c*, 25*b* in this article.

Pointillism: *see* page 31*c* in this article.

Postimpressionism: style of French painting which followed impressionism; period from about 1880 to 1905; leading artists, Cézanne, Gauguin, Seurat, and Van Gogh.

Pre-Raphaelites: a group of English painters and poets of the mid-19th century. They sought to abandon the academic conventions and classicism of the time and return to the artistic freedom of the painters before Raphael, hence their name. Their works are characterized by delicacy and by scrupulous fidelity to detail. The painters included Hunt, D. G. Rossetti, Millais, Burne-Jones, Watts, Alma-Tadema, and Leighton.

Primitive Art: *see* page 31*a* in this article.

Realism: a French movement of the 19th century. Gustave Courbet gave the movement its name with a one-man show in Paris in 1855, called "Le Réalisme, G. Courbet." He declared that "nothing at all should be invented; only things actually seen should be painted." Realistic painters observed their subject objectively and depicted it undramatically.

Rococo: *see* Baroque in this list.

Romanticism: early 19th-century movement, emotional and vital, in revolt against the cold severity of neoclassicism; depicted the unusual and exotic; Géricault and Delacroix were chief representatives.

Salon: a public exhibition of works of arts; specifically, an exhibition sponsored by the Academy of Fine Arts, Paris.

Still Life: a painting of inanimate objects; widely used by modern artists because it best lends itself to purely formal compositions.

Surrealism: *see* page 34*d* in this article.

Tempera: *see* pages 37*b–c* in this article.

Water Color: *see* page 37*c* in this article.

REFERENCE-OUTLINE FOR STUDY OF PAINTING

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  B. **Giotto** P-25-25*a*, G-110-11 ('The Descent from the Cross', color picture P-25*a*; 'Adoration of the Kings' C-293)

Note: See also in Fact-Index Duccio di Buoninsegna; Gaddi, Taddeo; Lorenzetti, Ambrogio and Pietro; Martini, Simone.

III. **Late medieval painting in northern Europe**
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  C. **Memling** P-25*b* ('Madonna and Child with Angels', color picture P-25*c*; 'Tomasso Portiniari' A-400*b*)
  D. **Bosch** P-25*b-c* ('The Vision of Tondalys', color picture P-25*d*)

Note: See also in Fact-Index Bouts, Dirk; Goes, Hugo van der; Limbourg brothers; Schongauer, Martin.

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Note: See also in Fact-Index Bartolommeo, Fra; Bellini, father and sons; Carpaccio, Vittorio; Corregio; Francesca, Piero della; Ghirlandaio, Domenico; Giulio Romano; Gozzoli, Benozzo; Lippi, Filippino; Lippi, Fra Filippo; Luini, Bernardino; Mantegna, Andrea; Melozzo da Forlí; Palma, Jacopo; Perugino; Pinturicchio; Pollaiuolo, Antonio; Sarto, Andrea del; Sebastiano del Piombo; Signorelli, Luca; Sodoma, Il; Tintoretto; Verrocchio, Andrea del.

II. **Northern Europe**
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Note: See also in Fact-Index Grünewald, Matthias; Matsys, Quentin.

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  B. **Giorgioni** G-110 ('Adoration of the Shepherds' G-110)
  C. **Veronese** P-27*a* ('The Finding of Moses', color picture P-27*a*)

Note: See also in Fact-Index Bronzino, Angelo; Canaletto, Antonio; Caravaggio, Michelangelo Amerighi da; Carracci, Ludovico; Domenichino, Zampiere; Guardi, Francesco; Guido Reni; Rosa, Salvator; Tiepolo, Giovanni Battista; Vasari, Giorgio.

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  C. **Vermeer** P-29*a* ('Young Woman with a Water Jug', color picture P-29*a*)
  D. **Van Ruisdael** P-29*b* ('Wheatfields', color picture P-29b)

Note: See also in Fact-Index Brouwer, Adrian; Cranach, Lucas; Cuyp, Albert; Douw, Gerard; Hobbema, Meindert; Hooch, Pieter de; Jordaens, Jacob; Metsu, Gabriel; Ostade, Adrian and Isaac; Potter, Paul; Steen, Jan; Teniers, David; Terborch, Gerard.

IV. **Spain**
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  B. **Velasquez** P-27*b*, *d*, V-439-40 ('Maids of Honor', color picture P-27*d*)
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Note: See also in Fact-Index Ribera, José; Zurbarán, Francisco de.

V. **France:** See in Fact-Index Callot, Jacques; Claude Lorrain; Clouet, François and Jean; Lebrun, Charles; Poussin, Nicolas

THE 18TH CENTURY

I. **England**
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C. **Gainsborough** G-1 ('The Honourable Mrs. Graham' G-1)

Note: See also in Fact-Index Cotman, John Sell; Hoppner, John; Kneller, Sir Godfrey; Lawrence, Sir Thomas; Morland, George; Raeburn, Sir Henry; Romney, George; Wilson, Richard.

II. **France**

—**Chardin** P-29*b* ('Blowing Bubbles', color picture P-29*b*). See also in Fact-Index Boucher, François; Fragonard, Jean-Honoré; Greuze, Jean Baptiste; Lancret, Nicolas; Lebrun, Elizabeth Vigée- ; Nattier, Jean Marc; Watteau, Jean Antoine

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E. **Landseer** L-93 ('Self-Portrait' L-93)
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Note: See also in Fact-Index Alma-Tadema, Sir Lawrence; Beardsley, Aubrey Vincent; Boughton, George H.; Brown, Ford Madox; Burne-Jones, Sir Edward; Hunt, Holman; Lavery, Sir John; Leighton, Frederick; Orpen, Sir William; Watts, George Frederick.

II. **France**

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Note: See also in Fact-Index Courbet, Gustave; Daubigny, Charles François; David, Jacques Louis; Delacroix, Eugène; Diaz de la Peña, Narcisse; Dupré, Jules; Géricault, J. L. A. Théodore; Gros, Antoine Jean; Ingres, Jean; Prud'hon, Pierre; Puvis de Chavannes, Pierre; Rousseau, Théodore; Troyon, Constant.

III. **Spain**

—**Goya** P-31*a* ('Señora Sabasa García', color picture P-31*a*)

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Note: See also in Fact-Index Gauguin, Paul; Morisot, Berthe; Pissaro, Camille; Redon, Odilon; Rousseau, Henri Julien; Sisley, Alfred; Toulouse-Lautrec, Henri de.

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Note: See also in Fact-Index Allston, Washington; Peale, Charles Willson; Peale, Rembrandt; Sully, Thomas.

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Note: See also in Fact-Index Abbey, Edwin Austin; Bingham, George Caleb; Cassatt, Mary; Church, Frederick E.; Cole, Thomas; Doughty, Thomas; Inness, George; Leutze, Emanuel; Remington, Frederic; Twachtmann, John Henry.

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Note: See also in Fact-Index Alexander, John W.; Biddle, George; Blashfield, Edwin Howland; Curry, John Steuart; Demuth, Charles; Gropper, William; Henri, Robert; Kuhn, Walt; Luks, George; Marsh, Reginald; Melchers, Gari; Sloan, John; Turner, Charles Yardley.

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- C. Chagall P-34*d* ('I and My Village', color picture P-34*b*)

Note: See also in Fact-Index Derain, André; Duchamp, Marcel; Dufy, Raoul; Ernst, Max; Forain, Jean Louis; Gris, Juan; Grosz, George; Kandinsky, Wassily; Léger, Fernand; Mondrian, Piet; Nolde, Emil; Segonzac, André Dunoyer de; Sorolla y Bastida, Joaquin; Utrillo, Maurice; Vlaminck, Maurice de; Zuloaga, Ignacio.

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PAINT—*What* IT IS *and How* IT IS MADE

PAINTS AND VARNISHES. Ordinary paint is used to cover up or decorate walls and other surfaces. It also helps to prevent decay. We see paint used everywhere in this way, outside and inside houses, and on other buildings and structures.

Paint makes it easier to keep surfaces clean and therefore sanitary. It can be used to intensify or soften the reflection of light. Special paints will keep metals from rusting, or make a surface fireproof or waterproof. Poison can be added to ward off parasites, and luminous paints will glow in the dark.

Nature and Kinds of Paint

Every paint has some fluid material which spreads when wet and leaves a film on the surface when it dries. This material is called the *vehicle*. The vehicle also carries coloring matter known as *pigment*.

The oldest and simplest kind of paint uses water as a vehicle. Artists call such paints "water colors." Children learn to use them at an early age. Water colors have also been used by some of the world's greatest artists (*see* Painting). But the most common paint has oil for a vehicle. Most oil paints have a *thinner* to make them spread easily in thin layers. The thinner evaporates rapidly and leaves the rest of the paint to harden gradually.

How Oil Paints Are Made

For an oil paint the vehicle is a *drying oil*. This kind of oil hardens gradually when it is exposed to air and clings firmly to the surface. Oxygen from the air gradually changes the chemical nature of the oil, and the molecules join together to make the hard film. This joining together of molecules to form larger molecules is called *polymerization*. Drying can be speeded up by using a *drier*. This substance speeds up the chemical change.

Pigments are of two kinds, *body* pigments and *color* pigments. The body pigment is usually white. It makes the paint opaque. Other pigments give color. The pigments are carried in the vehicle as fine particles; they do not dissolve. If they did the paint would be transparent, like a dye or stain.

Oil Vehicles, Driers, and Thinners

The most common vehicle is linseed oil, made from flaxseed. Raw linseed oil dries slowly and forms a tough, elastic film. Boiled linseed oil dries faster; the film is hard but brittle. Some paints have each kind of oil. More commonly, raw oil is mixed with a Japan type of drier.

In some paints, a drier is added to the oil and heated before pigment is added. This starts the chemical hardening; but hardening cannot proceed until the paint is exposed to air. Among these driers are oxides of manganese, lead, or cobalt, and manganese borate. Other driers may be added just before the paint is used. These include highly oxidized linseed oil and compounds called *metallic soaps*. Among them are lead acetate, lead resinate, and manganese oleate. Japan driers contain a metallic soap and a resin such as shellac or rosin.

Extremely fast drying is given by tung oil (also called China wood oil). If castor oil is carefully dehydrated (to drive out water), it makes an excellent drying oil. It came into wide use when the second World War cut off imports of tung oil. Less commonly used drying oils are treated soybean, perilla (from the Far East), and oiticica (from northern Brazil). Attempts to make drying oils from petroleum have met with limited success.

To reduce the thickness of the paint so that it can be properly applied a *thinner* is added. The most commonly used thinner is turpentine (*see* Turpentine). Its rate of evaporation gives good brushing and flowing qualities to the paint. Turpentine also has good solvent properties and it carries oxygen to the drying oil. Other thinners called *petroleum spirits* are made from petroleum. *Solvent naphtha* thinners are made from coal tar.

Body and Color Pigments

The commonest body pigment is *white lead*, made by electrolysis or other methods. The *Old Dutch* and the newer *Carter* processes expose metallic lead to acetic acid and carbonic acid gas. These acids change the lead to basic (nonacid) lead carbonate. Sand particles coated with lead can substitute for lead particles to save two thirds of the amount of lead normally used in outdoor paint.

Lithopone, another common body pigment, is used only for interior paint because sunlight can discolor it. It is made of barium sulfate, zinc sulfide, and zinc oxide.

Titanium white is from two to three times as opaque as white lead. It is usually mixed with barium sulfate and zinc oxide to improve durability. Most titanium white is made from ilmenite and rutile, ores found in parts of the United States, Canada, Norway, and India. Dissolving the ore in acid forms titanium sulfate. Treatment with alkali changes this to a hydroxide, which is then calcined (heated) to form the pigment.

For its brilliant whiteness *zinc white* (zinc oxide) is often mixed with white lead. It can be made by the French or American process. In the French process, zinc is heated until it is vaporized in a current of air. There it combines with oxygen to form zinc oxide, and the air current deposits the oxide in collecting chambers. In the American process, franklinite ore found in New Jersey is granulated and burned with powdered anthracite. Vaporized zinc passes into a blast of air and forms zinc oxide.

Certain other pigments such as *whiting* (calcium carbonate) or *barytes* (barium sulfate) are called *extender* pigments. In small quantities they add to the durability of paints. In large quantities, however, they greatly reduce the covering qualities and are considered adulterants.

Color pigments contain coloring matter mixed with oil to form a paste. The colors are most commonly obtained with the following materials:

Black—carbon black, including lampblack;
Prussian Blue—ferric ferrocyanide;
Cobalt Blue—cobalt aluminate;
Red—ferric (iron) oxide;
Vermilion—mercuric sulfide;
Yellows: chrome—lead chromate;
Ochre—limonite (a yellow iron ore); also various compounds of zinc, arsenic, or cadmium;
Greens: chrome—chromium sesquioxide;
Copper—malachite (a green copper ore); also various mixtures of blue and yellow pigments.

Paints for Special Purposes

Metallic pigments, called "bronzes" in the paint trade, are formed from powdered aluminum, copper, brass, or bronze. They give the paint a silvery or golden luster. Paints made in this way have good reflecting power and protect surfaces from the effects of light and heat.

Asbestos, borax, powdered glass, and other retarders of fire are added to the usual formulas to make fireproof paints. Sulfides of barium, strontium, or calcium make luminous paint. An extremely small amount of a radioactive substance has the power to make zinc sulfide glow in the dark, and this treated substance is used in the manufacture of luminous watch and clock dials. Copper or mercury oxides added to paints protect ship bottoms from such harmful marine parasites as barnacles and worms.

Calcimine and Other Water Paints

The simplest water paint is *calcimine.* Usually the vehicle is a mixture of water and a binder (animal glue or dextrin) which dries and holds the pigment to the surface. Whiting is the principal pigment. Calcimine is an economical, quick-drying coating for interior walls and ceilings where little protection from the weather is needed.

Another simple paint of this type is made of water, casein as a binder, lithopone or whiting as a body pigment, and color pigment. A greatly improved type uses oil varnish combined with casein. This type is sold as a paste and is mixed with water for use. No great skill or experience is needed to apply either kind. The oil-varnish type shows much better resistance to water than the older casein paints, and some kinds give high gloss.

In water colors for artists, the binders used are gum arabics, glycerine, honey, glucose, or ox gall. Preservative and pigment are added.

Varnishes and How They Are Made

A true varnish is a mixture of resin and drying oil, or of other substances which have similar properties. It lies on a surface as a transparent, glossy coating which shows the material underneath. The driers and thinners used with varnishes are usually the same as used in paints.

The oldest types are called *oleoresinous,* from the oil and resin they contain. These ingredients are cooked together or blended in a thinner. They dry much as do paints, by oxidation and polymerization. Originally all the resins were produced by trees, living or dead. Today these natural resins are being replaced by synthetic materials. The following resins and synthetic materials are used:

Copal resins—from such fossils as Congo fossil, Zanzibar, Pontianak, and Kauri. They are found in deposits left by trees long extinct.
Dammar resins—from living trees in India, East Indies, Australia, and other Pacific islands;
Mastic—from a Mediterranean pistache tree;
Synthetics—plain and modified ester gum (glyceryl rosinate); phenolformaldehyde resins;
Rosin—distilled along with turpentine from the sap and wood of various species of pine.

Differences in heat treatment, the proportion of resin to oil, or addition of some minor ingredient greatly changes the characteristics of an oleoresinous varnish. Waterproof and elastic spar varnishes have a high proportion of oil and therefore are said to be "long" in oil. Hard and quick-drying floor varnishes are "medium" in oil, while high gloss furniture varnishes are "short" in oil.

Alkyd varnishes are made by complex chemical reactions between oils and other materials, principally glyceryl phthalate. The glyceryl phthalate permits the use of much slower drying oils like soybean oil or even nondrying stearin (solid material from certain animal and vegetable fats and oils). The 100 per cent synthetic resin varnishes include solutions of phenolformaldehyde, ureaformaldehyde, and melamineformaldehyde resins. Due to their great brittleness, the latter two are usually found in combination with the alkyd varnishes.

Enamels, Lacquers, and Stains

The surface coatings called enamels are pigmented *varnishes* containing resin. They are distinguished from paints which are pigmented *oils* and from porcelain enamels or glazes (*see* Enameling). The varnishes used in enamels are made as pale and transparent as possible. This improves the color quality of the body and color pigments. Titanium white is the usual body pigment, because it is chemically inactive.

The oriental lacquers so often seen on Chinese furniture and other art objects are similar to paint enamels in some ways. At one time they were the hardest and most durable of all surface coatings. They are made from "natural varnishes" derived from the sap of a species of poison sumach. These oriental lacquers, however, are altogether different in composition from modern synthetic lacquers. (*See* also Lacquers and Shellac).

The substances classified as *stains* are distinguished from paints in that they do not produce a surface coating. They are in fact merely wood dyes which penetrate and color the fibers, leaving the grain and structure of the wood plainly visible. Depending upon the liquid in which the dyes are dissolved, stains are classified as spirit stains, oil stains, and water stains. Certain stains are designed to bring about chemical changes in the wood fiber to make it acid-proof or heat-resistant. Stained surfaces are often made glossy and waterproof by coats of varnish or by rubbing in an oil or a wax.

Methods of Applying Paint

For a paint to adhere properly there must be no water, grease, or dirt on the surface to be painted; otherwise blistering may take place, which loosens

the paint and lets it chip off. Knots in resinous wood should be shellacked before painting. Paint applied in weather below 40°F. will not dry properly and may sag. If paint is too thin or applied too abundantly, running or sagging may occur.

When painting new surfaces a priming coat is first applied. This is usually a thin flat paint which has good adhesive properties and which provides a grainy surface to which following coats can stick. A second, or body, coat and a third, or finishing, coat are then applied. In repainting, the priming coat is omitted.

Paints, varnishes, or lacquers may be applied by brush or spray gun. An absorbent fleece-covered roller may be used for painting. Paintbrushes are usually made from nylon or black Russian or Chinese boar bristles. For spraying, the paint must be made thin. Air pressure of at least 40 pounds a square inch is required.

Nearly all kinds of paint are sold ready mixed and color standardized for inexperienced persons to use; but most expert painters prefer to mix their own colors. The body pigments are sold in the form of a paste, ground in linseed oil. To this paste is added more linseed oil, either raw or boiled, a drier, and a thinner. Color pigments are then stirred into the paint until the desired hue is produced.

Paint Removers and Decalcomania

Paint may be removed by applying a solution of lye in water to the surface. This undermines the paint and loosens it so that it may be scrubbed off. The lye, however, roughens the surface of the wood. Less harsh removers consist of solutions of benzene, wood alcohol, and acetone. This type of remover softens the paint or varnish so it may be scraped away.

Much decorative painting that used to be done by hand is now imitated by the decalcomania process. Paper is coated first with dextrin, second with varnish or lacquer, and last with a printed design, or with dextrin, printing, and varnish.

When the decalcomania paper is moistened and pressed on wood, metal, glass, or porcelain, the film with its design comes off the paper and transfers itself to the new surface. The design itself is waterproof and when dry stays firmly in place.

PAKISTAN. Indian Moslems rejoiced on Aug. 15, 1947, when their long struggle for self-government brought the creation of the independent nation of Pakistan. Inspired by religious zeal and national spirit, they began the immense task of turning their underdeveloped land into a stable, modern nation.

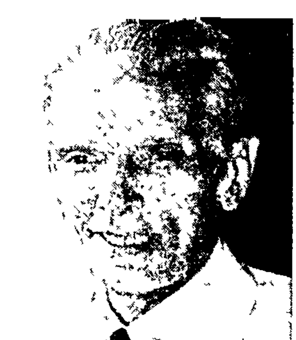
Pakistan's land is divided. It consists of two huge areas in the northeast and northwest of the Indian subcontinent, about 1,000 miles apart. It includes the regions where the people of the Moslem religion were in the majority when Great Britain gave up its Indian Empire to the new nations of Pakistan and India (*see* India). Pakistan is a dominion in the British Commonwealth of Nations.

Its population is huge. It is the sixth most populous nation in the world and the most populous Moslem nation. Most of its 75,842,165 people are poor farming folk and only 13.8 per cent can read. Leaders of the new nation had difficulty finding men capable of doing government work or operating powerhouses, trains, and telegraph offices. Under Great Britain, Hindus and Sikhs had held these jobs and were the business and professional men. In the religious riots after the subcontinent was divided, millions of Hindus fled to India and millions of Moslem peasants poured from India into Pakistan. The care of the refugees added to the nation's economic burdens.

Two Contrasting Areas

The two parts of the country—East Pakistan and West Pakistan—differ greatly. East Pakistan lies at the head of the Bay of Bengal, with India surrounding it on the west, north, and northeast. The narrow Chittagong hills section on the southeast borders Burma. The land is a vast alluvial plain stretching across most of the delta of the Ganges and Brahmaputra rivers. It is cut by a network of streams and tidal creeks and rarely rises 300 feet above the sea. The rivers carry

PAKISTAN AND ITS CREATOR



The new nation of Pakistan was carved out of India in two separate sections. This was brought about largely by one man, Mohammed Ali Jinnah (right). When his country was established (Aug. 15, 1947) he became its head. The constituent assembly confirmed his popular title, *Quaid-i-Azam* (the great leader).

Extent.—West Pakistan, greatest distance east to west, about 700 miles, north to south, about 800 miles; area, 310,236 sq. mi.; population, 33,779,555. East Pakistan, east to west, about 260 mi., north to south, about 360 mi.; area, 54,501 sq. mi.; population, 42,062,610. Total area, 364,737 sq. mi.; population, 75,842,165.

Natural Features.—Broad Indus plain from which rise Kirthar, Sulaiman, Hindu Kush, and Salt ranges in the west and north. In the east, river plain and delta of Brahmaputra and Ganges rivers.

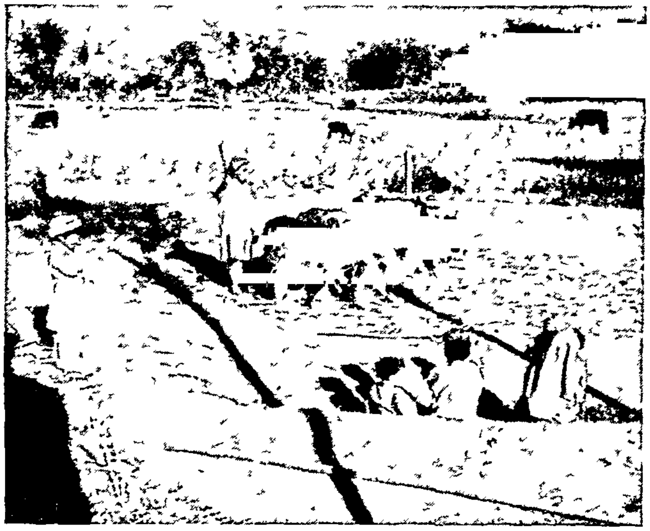
Products.—Rice, wheat, coarse grains, jute, cotton, tea, tobacco, sugar, fruit, hides, skins, wool; fish; coal, rock salt, chromite, gypsum.

Provinces and States.—East Pakistan: only East Bengal (including Sylhet hills region formerly in Assam). West Pakistan: Sind in southeast; Punjab in northeast; Northwest Frontier Provinces and tribal areas; Baluchistan in southwest. States: Makran, Las Bel, Kalat, and Karan in Baluchistan States Union; Bahawalpur and Khairpur in east; Chitral, Dir and Swat in north.

Cities.—Karachi (capital), 1,009,438; Lahore, 849,476; Dacca, 411,279; Chittagong, 294,046; Hyderabad, 241,801; Rawalpindi, 237,219; Multan, Lyallpur, Sialkot, Peshawar, Gujranwala (over 100,000).

A STREET IN THE CAPITAL AND A WEST PAKISTAN FARM

Bicycle "rickshas" mingle with motor traffic on Karachi's busy Bunder Road. The domed structure is the municipal building.



On this Punjab farm donkeys and a cow tread out the grain on the threshing floor. Notice the foothills rising from the valley.

silt down from the Himalayas in the north, which enriches the soil. The rivers also provide fish for food and waterways for transport. In the south, marshy fingers of land stretching into the sea are covered with a dense mangrove forest. In this area, called the Sundarbans, roam wild animals, including tigers, wild hogs, leopards, deer, and bears. East Pakistan is one of the world's most thickly settled farming areas, with 777 persons to the square mile.

West Pakistan stretches from the head of the Arabian Sea northward to the Hindu Kush range in central Asia's mountain wall. Its neighbors are India on the east, Iran on the southwest, Afghanistan on the northwest, and the state of Kashmir in the northern mountains. Down from these mountains pour the huge Indus River and its chief tributaries, the Jhelum, Chenab, Ravi, and Sutlej. The broad valley of these rivers is West Pakistan's heartland, and their waters are used to irrigate its dry soil (*see* Indus River). The gray, sandy Sind Desert in the southeast is a continuation of India's barren Thar Desert. Between the Indus River and the Iran and Afghanistan boundaries rise high, rugged mountains. The principal range, the Sulaiman, towers to heights above 11,000 feet. Nearly six times as large as the eastern part in area, West Pakistan's population density is only 108 people to the square mile.

Differences in Climate and Rainfall

East Pakistan has humid tropical to subtropical weather without extreme changes. From March through October the mean average temperature is about 83° F., and in the cooler season about 64°. The southwest monsoon brings heavy rain between June and October when it blows in from the Bay of Bengal laden with moisture (*see* Winds). The annual rainfall varies from 70 inches in the lowlands to more than 300 in the Sylhet hills.

West Pakistan is dry and subject to extreme weather changes. The fierce summer sun raises daytime temperatures to 120° F., though the nights are usually cooler. In winter frost nips the plains and the mountains are clad with snow. The annual rainfall ranges from almost none in the desert to between 15 and 30 inches in the north. The area gets little moisture from the monsoons.

Peoples, Religions, and Languages

The peoples of the two sections differ also. The Bengali of East Pakistan are of mixed Mongoloid and Dravidian stocks and tend to be small and dark skinned like their Indian neighbors. The people of West Pakistan are taller and fairer and are mixtures of Indo-Iranian stocks.

Religion is the unifying force in this divided land. More than 80 per cent of the people are Moslems. Most of the remainder are Hindus (*see* Mohammed and Mohammedanism; Hinduism). The Urdu language is understood by educated people. Millions, however, speak only provincial languages, including Bengali, Punjabi, Sindhi, and Pushtu. English is widely used in business and government.

How the People Live

Between eight tenths and nine tenths of the Pakistani are farming people who live in rural villages. Most homes are of mud or mud brick, but in the rainy east bamboo huts are built on stilts or mounds. Life is an unending struggle to make a living with inadequate land and antiquated tools and methods. Their way of life is much like that of their Indian neighbors described in the India article, subhead "How the People Live." Naturally there are variations in ways, customs, and folklore in the various sections. In the western mountains, wandering herders follow their sheep and goats in search of pasture. Their families carry their tents and furnishings on camels and donkeys as they migrate from winter pasture in the lowlands to summer grass in the mountains.

Formerly upper- and middle-class Moslem women conformed to the custom of "purdah," living in a separate part of their homes and never showing their faces to men other than close relatives. In public they

covered themselves with a tentlike garment called a *burka*. Today it is estimated that fewer than 10 per cent of Pakistan's women follow this custom. The All Pakistan Women's Association is campaigning for the social, educational, and cultural advancement of women. New schools and colleges have been built for girls.

The usual costume of the women is a pair of loose trousers, known as *shalwar*, topped by a tunic and sheer veil. Formal dress for men consists of tight trousers and a knee-length coat, the *sherwani*. In East Bengal men commonly wear the *lungi*, which is similar to the Indian *dhoti*. Women wear the *sari*.

Agriculture and Irrigation

Agriculture supports from 80 to 90 per cent of the people. There is an average of only half an acre of tillable land per person, but two or more crops may be raised in a year. In warm, humid East Pakistan the chief crops are rice, about three quarters of the world's jute, tea from the hilly regions, tobacco, oil seeds, and sugar cane. Leading products in dry West Pakistan are wheat, rice, millet, cotton, tobacco, sugar cane, fruit, and livestock. It has a grain surplus in normal years.

Irrigation is required for some 80 per cent of the farms in West Pakistan. Irrigation systems were already extensive before 1947. Then the new government gave top priority to a huge program of irrigation projects in its long-range development plans. Among the largest were the Lower Sind project, based on the Kotri Barrage (dam), and the Thal project, based on the Jinnah Barrage, both in the Indus River. In the Thal area 2 million acres are being reclaimed and 240 new villages are being constructed to settle refugees and other landless farmers. New hydroelectric projects are also important in the national drive to supply power for industrial development.

Trade and Industry

Jute, cotton, hides and skins, tea, and wool make up 90 per cent of Pakistan's exports. With few factories and a meager mineral output, it must import textiles, machinery and appliances, metals, ores, coal, and petroleum. The government has sponsored the building of factories to process its raw materials and to make consumer goods. Despite its progress, fewer than one per cent of the people are industrial workers, even if railway, marine, dock, and mine laborers are included. Many men and women work in their homes making famous wares such as the handwoven fabrics of Dacca, copperware of Persian design from Peshawar, other metalwork, gold and silver jewelry, carved ivory, and the athletic equipment of Sialkot.

Each part of Pakistan has its own railway system. The two parts are connected by ocean and air transportation and by radio telegraph and telephone. Railway, radio, telegraph, telephone, and postal services are government operated. Highways are maintained by the provinces but the roads are poorly developed, with only about 12,000 miles of hard surface.

Karachi is the chief air and ocean port. Its population tripled after it became the nation's capital. Chittagong is the chief port in the East. Dacca, capital of East Bengal, and Lahore, in the Punjab, are noted for their fine Moslem architecture.

History and Government

Pakistan and India shared their history until 1947. West Pakistan's Khyber Pass and Indus Valley formed the invasion highway for India's ancient conquerors, many of whom carried the faith of Islam. Most of India was under Moslem rule during the Mogul Empire. After its decline in the 18th century, Great Britain gradually assumed control.

The Moslem League was founded in 1906 to seek political rights for Moslems. Its president after 1926 was the "father of Pakistan," Mohammed Ali Jinnah. For a time he co-operated with India's Congress party in working for a free, united India. Then the Moslems decided that their rights would not be respected by a Hindu majority. In 1940 Jinnah demanded a separate Moslem state—Pakistan, "country of the pure."

When Britain announced that it would leave India in 1947, Jinnah stood firm and the Congress party

RAINY EAST PAKISTAN'S GREAT CROPS—RICE AND JUTE

Rice threshing in this slow, crude way is typical of East Bengal farming. Notice the lush vegetation in this moist land.

These workers are hanging jute fibers up to dry. The fiber can be removed from the stalks (rear) only after long soaking.

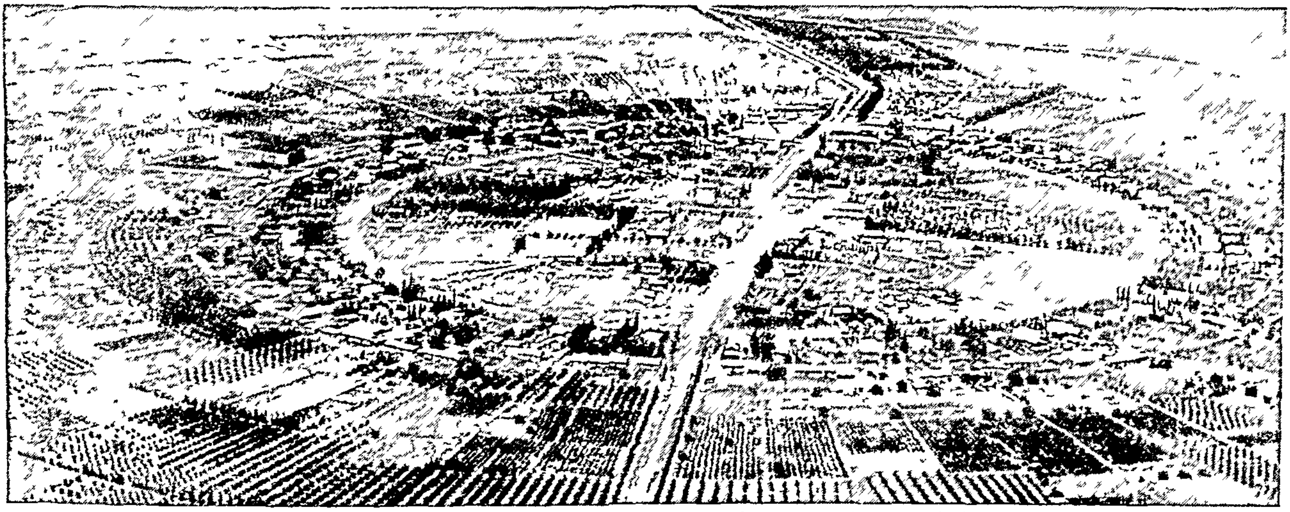
reluctantly agreed to partition. Jinnah was governor general of Pakistan until his death in 1948.

A constituent assembly was set up to draft a constitution, but differences of opinion delayed progress. Meanwhile the assembly acts as the federal parliament. Its members are named by the democratically elected provincial legislatures. The governor general is the head of the state. He appoints the prime minister who selects cabinet members. The cabinet, responsible to the assembly, carries on the government.

The new government set up long-range plans for the development of irrigation and land reclamation, hydroelectric power, new industry, modern agricultural methods, education, public health, and social welfare activities. It floated huge loans to carry out these costly plans and received financial aid and technical assistance from United Nations agencies, the World Bank, and Colombo plan nations. United States allocations alone amounted to 141 million dollars by mid-1954.

Friction between Pakistan and India hampers both nations. Religious riots and massacres followed partition. The two countries were at war in 1947–48 for possession of Kashmir, and they maintain armies in the area that neither can afford (*see* Kashmir). Another long-standing dispute concerns irrigation water flowing from India to Pakistani territory. Steps toward co-operation include an agreement in 1950 to grant full rights to religious minorities and a trade pact in 1951. The Indians objected when the United States gave Pakistan military aid in 1954 to strengthen the barrier against possible Communist penetration down the ancient invasion route. (For Reference-Outline and Bibliography, *see* India.)

EAST *Meets* WEST *in Changing* PALESTINE



The Plain of Esdraelon, also called the Emek, is the garden spot of Palestine, as it was in Biblical times. The houses in this Jewish farm colony are built around a circle; the fields reach out spokewise. The land is worked as a single farm.

PAL'ESTINE. Turning its back to the vast Arabian Desert, the narrow strip of land called Palestine looks out over the eastern Mediterranean. It is only 60 miles wide and little larger than Vermont; but it possesses an importance all out of proportion to its size. For Palestine is regarded as the Holy Land by Christian, Jew, and Arab alike. Christians think of it as the land where Jesus was born, taught his disciples, and was crucified and buried. To the Jews it is the Promised Land to which Moses led his people from Egypt. The Arabs rank Jerusalem after Mecca and Medina as a holy city because it was here that Mohammed tethered his horse on the night of his miraculous ride.

For ages many Jews had looked with devotion and longing to their ancient home, and some returned and settled there even under the oppressive rule of the Turks. Following the first World War Great Britain took over the government under a mandate from the League of Nations, and the Zionists' dream of establishing a Jewish National Home began to be realized. Jewish settlers poured in, bringing to the primitive Middle East the machinery and scientific knowledge of the West. With every shipload of immigrants the hostility of the Arabs increased, not only in Palestine but throughout the Middle East.

In 1947 the British announced their intention of giving up their Palestine mandate. The United Nations proposed that it should be split into two states, Arab and Jewish, and drew up boundaries. The British left in 1948 and the Jews set up an independent state, Israel. War broke out at once with the Arab states. The Jews were victorious and retained the territory they had won. The proposed Arab state never came into existence. The Arab kingdom Trans-Jordan (later called Jordan) annexed areas west of the Jordan that were occupied by its troops when the war ended. Egypt also retained a small Arab area. (For map, *see* Israel.)

A Small Land with Varied Scenery

Britain's Palestine mandate covered about 10,430 square miles. It was half as wide and twice as long as the Palestine of Bible times. The eastern boundary was the Jordan River. In the south it included the desert area known since ancient times as the Negeb.

The populous country to the north is nearly covered by stony hills. They rise gradually from a narrow coastal plain along the Mediterranean to an average height of 2,500 feet, making a long backbone which runs through the country from north to south until it loses itself in the desert sands. The eastern slope of this watershed abruptly plunges 4,000 feet down into the deepest trench in the world—the valley of the Jordan River and the Dead Sea. The surface of this sea lies a quarter of a mile *below* sea level.

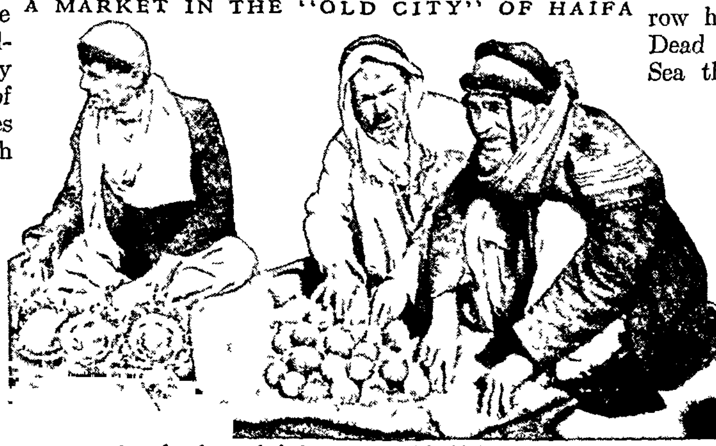
TEL AVIV, THE ALL-JEWISH METROPOLIS

With its modernistic architecture, paved streets, gardens, and bathing beach, Tel Aviv is the most modern city of the eastern Mediterranean region. Built on sand dunes along the coast, its name means "Hill of Spring."

The regular coast line is broken only in the north, where the headland of Mount Carmel juts into the sea, forming a natural deep harbor at Haifa. This important port lies at the junction of two plains over which traffic has moved since the most ancient times. One is the coastal plain leading down to Egypt; the other is the Plain of Esdraelon (the Emek), which cuts through the mountains into the Jordan Valley and is the gateway to the East. Deep rich soil, watered by the Kishon River, makes the Plain of Esdraelon the garden spot of Palestine. Dairy and poultry farms, vegetable gardens, and wheat fields surround the red-roofed cottages of the Jewish agricultural settlements.

The coastal plain has a lighter, sandier soil suited to fruit culture. Only two or three miles wide north of Haifa it broadens south of that city into the fertile Plain of Sharon, about 20 miles wide. Here the Jewish agricultural villages are surrounded by groves of oranges, lemons, and grapefruit, laid out with mathematical precision and irrigated by the most up-to-date methods; and here also are thriving Arab plantations whose owners have profited from Western ways. The sweet Jaffa orange grown here is one of the chief products of Palestine.

A MARKET IN THE "OLD CITY" OF HAIFA



Arabs, wearing shawls on their heads tied with thick cords, are here seen displaying their wares next to a Jewish vendor in a skull cap. For years most of the Jews and Arabs got along well together.

At the southern end of the Plain of Sharon the sparkling, modern city of Tel Aviv adjoins the ancient Arab port of Jaffa, where close-packed oriental houses cling to a rocky promontory. South of Jaffa the wide coastal plain is called Philistia. Here there is less water for irrigation, but grapes are grown and fields are covered with wheat and barley.

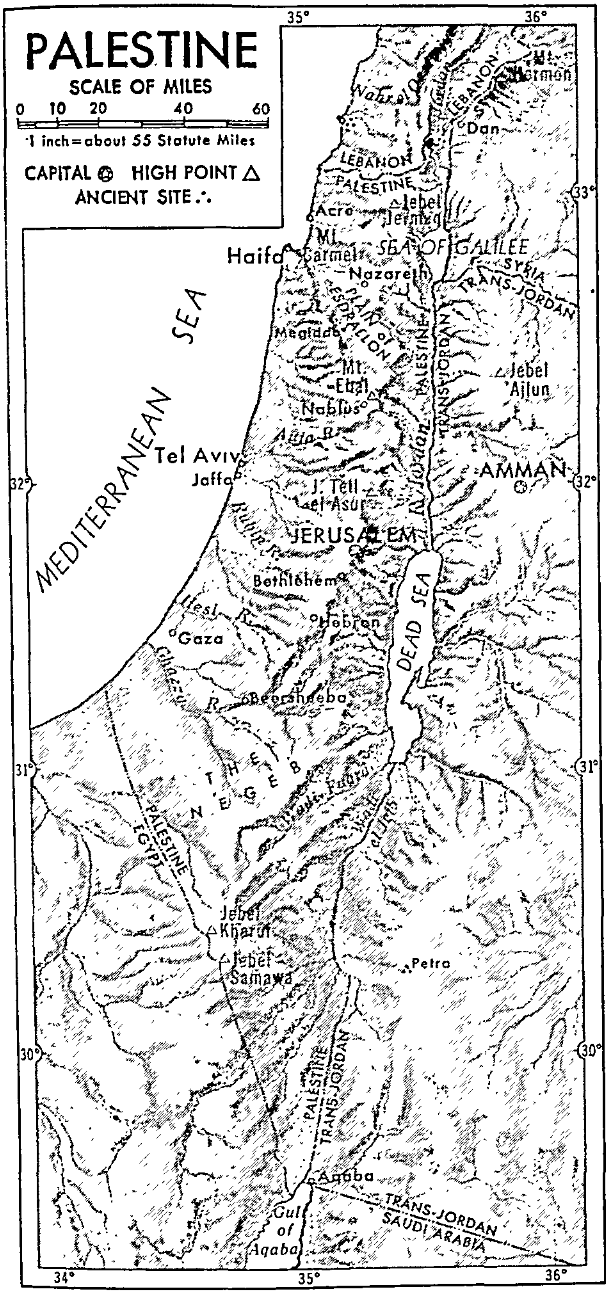
Beyond the coastal plains rise the stony and arid hills which cover most of Palestine. Here Arab peasants live in a thousand medieval villages crowded around springs or wells and surrounded by vineyards and by olive and fig trees. They raise scanty crops of wheat and barley in fields tilled with wooden plows yoked to oxen or camels. In the mountains they pasture flocks of goats and fat-tailed sheep. The highlands of Galilee in the north receive the most rainfall, and springs abound. Here Jebel Jermaq, the highest point in Palestine, rises to 3,934 feet. Water is less plentiful in Samaria, below the Plain of Esdraelon; and Judea, in the south, is a bare and stony tableland, where the people have always had to struggle for both soil and water.

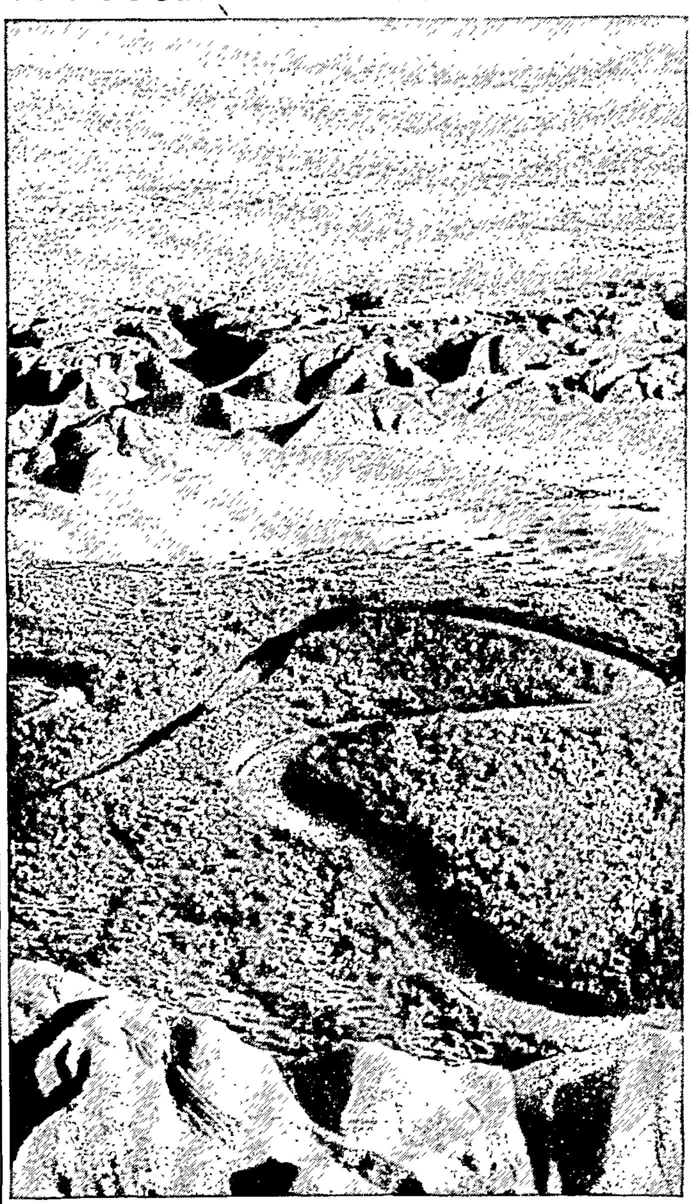
Yet Judea was the heart of ancient Palestine and contains its most famous cities. (*See* Jerusalem; Bethlehem.) A few breaks in the tableland are rich in vegetation; and where ancient terraces have been rebuilt patches of olive trees and vineyards contrast sharply with bare limestone rock. South of the tableland lies the desert, and to the east is the desolate Wilderness of Judea, through which a precipitous road winds down from Jerusalem to Jericho.

The Jordan Plunges Down to the Dead Sea

The turbulent Jordan River rises at the foot of Mount Hermon in Syria, spreads into the marshes of Lake Huleh and into the beautiful Sea of Galilee, and then meanders through a narrow hot valley toward the Dead Sea. Near the Dead Sea the valley widens and here on an oasis in the wilderness lies Jericho, 820 feet below sea level. The Dead Sea itself is almost 1,300 feet below the surface of the Mediterranean. This inland lake has no outlet to the sea; but so great is the heat that evaporation carries off most of the six million tons of water poured

MAP AND AIR VIEW OF RUGGED PALESTINE





The airplane view looks east across the valley of the lower Jordan River. After leaving the Sea of Galilee, the swift stream becomes sluggish and turns and twists for 200 miles to cover the 65 miles to the Dead Sea. The channel is hemmed in by jungle growth. Beyond stretches a treeless rocky waste, deeply seamed by wadis.

into it daily by the Jordan River and a half dozen smaller streams. This leaves a saturated solution of mineral salts. Fish die on reaching the Dead Sea, and little animal life is found on its desolate shores, which are bare of vegetation except at the mouths of fresh-water streams.

Two Seasons and Three Climates

Palestine has only two seasons but a variety of climates—subtropical on the coastal plains, mildly temperate in the highlands, and tropical in the valley of the Jordan, which is shut off by the mountains from cool rain-bearing winds. Except in the Jordan Valley rainfall is considerable, but it is not evenly distributed throughout the year. The rainy season lasts from October to April, with heavy rains in January and February. Grains are planted in October to be harvested in the spring. During the summer the ground dries up and plants wither. Fruit trees and vegetables depend upon irrigation, which is practised wherever water is available. Only a few streams contain water the year round. Most of the rainfall percolates through the limestone rock and reaches the sea subterraneously. In the plains, water is easily obtained by boring wells, but in the highlands wells are difficult and costly.

The People of Palestine

The population is as varied as the country and the climate. The Arabs are now a small minority. Most of them are peasant farmers, called *fellahs*. With their primitive methods they can hardly make a living from the stony soil. Yet they must give much of their produce to their landlords, called *effendis*. The

Christian Arabs, most of them members of the Greek Orthodox Church, are found chiefly in the towns.

The Jews also form a mixed group. The Sephardic Jews (descendants of Jews expelled from Spain) have lived in Mediterranean lands for generations. Many of them speak a mixture of Spanish with Hebrew and Arabic. The Ashkenazic, or European, Jews have come from many countries. They speak many different languages and have brought with them various social and political theories. In all groups the younger generation speak Hebrew.

REDEEMING THE LAND

Young Jewish pioneers like these restored the fertility of the long-neglected land.

Palestine's Early History

During most of its early history, little Palestine was ruled first by one then by another of its powerful neighbors—Babylonia, Egypt, Assyria, or Persia. It had been invaded by Semitic tribes at a very early date, and was known as the land of the Canaanites before the Israelites entrenched themselves in the hill country about 2000 B.C. (*see* Jews). At the time of the birth of Christ, Palestine was part of the far-flung Roman Empire.

The Jews began to leave their homeland in A.D. 70, when the Romans destroyed Jerusalem. Only a few thousand remained when the Arabs invaded Palestine in the 7th century. In 1072 the Seljuk Turks took Jerusalem. Except for a period during the Crusades Palestine remained under Moslem rule until it was freed by the Allies during the first World War. In 1920 Great Britain took over the administration of Palestine under a League of Nations mandate.

The Jews Return to Palestine

For some years movements had been under way to make Palestine a Jewish homeland. In 1897 a Viennese, Theodor Herzl, convened a congress of Jews at Basel, Switzerland, and founded the World Zionist Organization. It aimed to restore the Jewish National Home in Palestine.

During the first World War, the Zionists, under the leadership of Dr. Chaim Weizmann, interested the British government in their cause. In 1917 Great Britain issued the famous Balfour Declaration, it stated that:

"His Majesty's government view with favor the establishment in Palestine of a National Home for the Jewish people, and will use their best endeavors to facilitate the achievement of this object, it being clearly understood that nothing shall be done which may prejudice the civil and religious rights of existing non-Jewish communities in Palestine, or the rights and political status enjoyed by Jews in any other country."

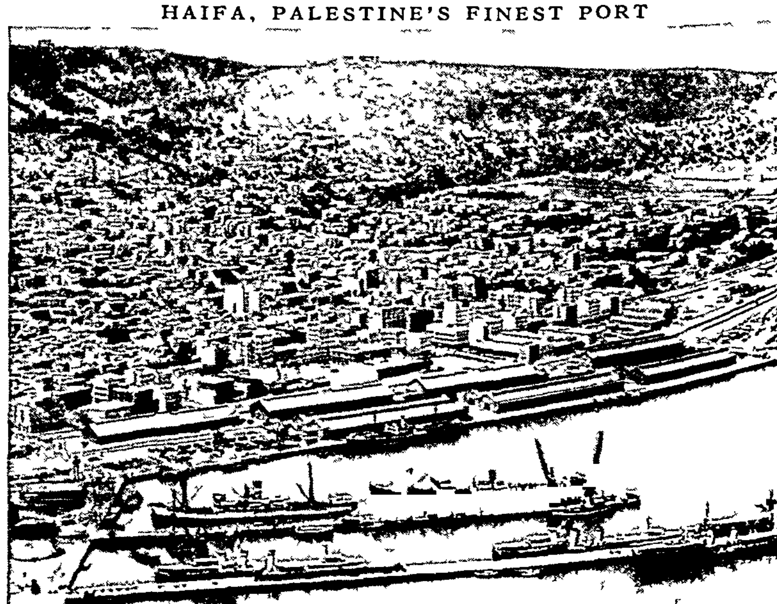
After the war Jews poured into Palestine from Poland and Russia and later from Germany. They came to a land that was one of the most poverty-stricken regions of the Middle East. The ancient forests had been cut down and the soil eroded from the slopes. Sand dunes had piled up along the coast, blocking the flow of streams to the sea and creating marshes. The fertile Plain of Esdraelon through centuries of neglect had become a land of pestilential swamps and barren wastes. The prospects for the newcomers were not promising.

The Country Is Transformed

Young Jewish pioneers, *Halutzim*, drained the swamps which were infested with malaria-carrying mosquitoes and prepared the land for settlement. Contributions poured in from Zionists in all parts of the world. Land was purchased through the Jewish National Fund, which leased it to individuals and communities.

Some colonies, called *Kvutzoth*, were established on a voluntary communal basis, with equal sharing of property by all. In another type of cooperative colony, the *Moshav*, each farmer was allotted his own fields. Other farms were owned by individuals who bought them from the Arabs, and some owners employed Arabs as well as Jews. A Jewish labor organization, the *Histadrut*, made up of farmers and town

HAIFA, PALESTINE'S FINEST PORT



On the slopes and at the foot of beautiful Mount Carmel is the rapidly developing city of Haifa. Its modernized harbor provides docking facilities for large ships. Some of the ships carry oil that has been pumped through a great pipe line from the rich oil fields of Iraq more than 600 miles away.

workers, trained immigrants for work on the land and organized co-operatives for irrigation, transport, marketing, health, and education.

The largest numbers of new arrivals crowded into the cities. The Jewish city of Tel Aviv, which had a population of only 1,000 in 1917, soon surpassed Jerusalem and became one of the most progressive communities in the Middle East. Outside the walls of old Jerusalem a new city and suburbs sprang up. At Haifa the harbor was modernized and Jewish homes spread over the green slopes of Mount Carmel.

Palestine lacks raw materials for manufactures; but a flourishing industry grew up on the shores of the Dead Sea, where Jews extracted potash, bromine, and salt from its briny waters. The Jordan River was harnessed and furnished power for many small factories. At Haifa, the terminus of an oil pipe line from Iraq, a large refinery was built.

ALONG THE MODERN ROAD TO JERICHO

On this legendary trail "a certain man went down from Jerusalem to Jericho and fell among thieves." The Good Samaritan rescued him. Today the trail to Jericho still winds down through the wilderness of Judea. But now it is the modern highway we see above. Diesel-engined trucks climb the road to Jerusalem with the products of the Dead Sea region.

Jewish funds built modern hospitals and educational institutions. The Hebrew Technical Institute was founded in Haifa and the Hebrew University on Mount Scopus in Jerusalem.

The Palestine Problem Becomes a World Issue

The rapid growth of the Jewish National Home alarmed the Arabs. They feared the Jews would become a majority in the population and a threat to Arab power. In 1929, following a religious quarrel at the Wailing Wall in Jerusalem, Arabs massacred Jews. In 1936 another riot broke out, caused by the increased immigration that followed Hitler's persecution of the Jews. In 1939 Britain issued a White Paper severely restricting immigration for five years and banning it altogether after 1944.

At the end of the second World War thousands of Europe's Jews sought admission to Palestine. Many attempted to enter illegally. The British blockaded the coast and carried the immigrants off to detention camps in Cyprus and other places. Jewish underground organizations answered the blockade with outbreaks of violence, blowing up buildings, bridges, and railways, and attacking British soldiers. Most active of the terrorist forces were *Irgun Zvai Leumi* and the Stern group. The more moderate *Haganah*, a Jewish force originally organized for defense against the Arabs, also offered strong resistance.

Because of Palestine's strategic position, its troubles concerned all the great powers. In 1947 Great Britain called on the United Nations to solve the problem. A commission recommended that Palestine be divided about equally into a Jewish state and an Arab state, with an international zone for Jerusalem. Britain protested and gave notice that it would resign the mandate on May 15, 1948. On May 14, a few hours before the British departed, the Jews proclaimed the state of Israel (*see* Israel). Population before partition, about 1,910,000.

PALM. Next to grains and other grasses, palms are the most useful of all plants. They give natives in many hot lands food, shelter, and something to sell. They provide raw material for many manufactured products. And they give welcome shade and beauty when they are planted as ornamental trees.

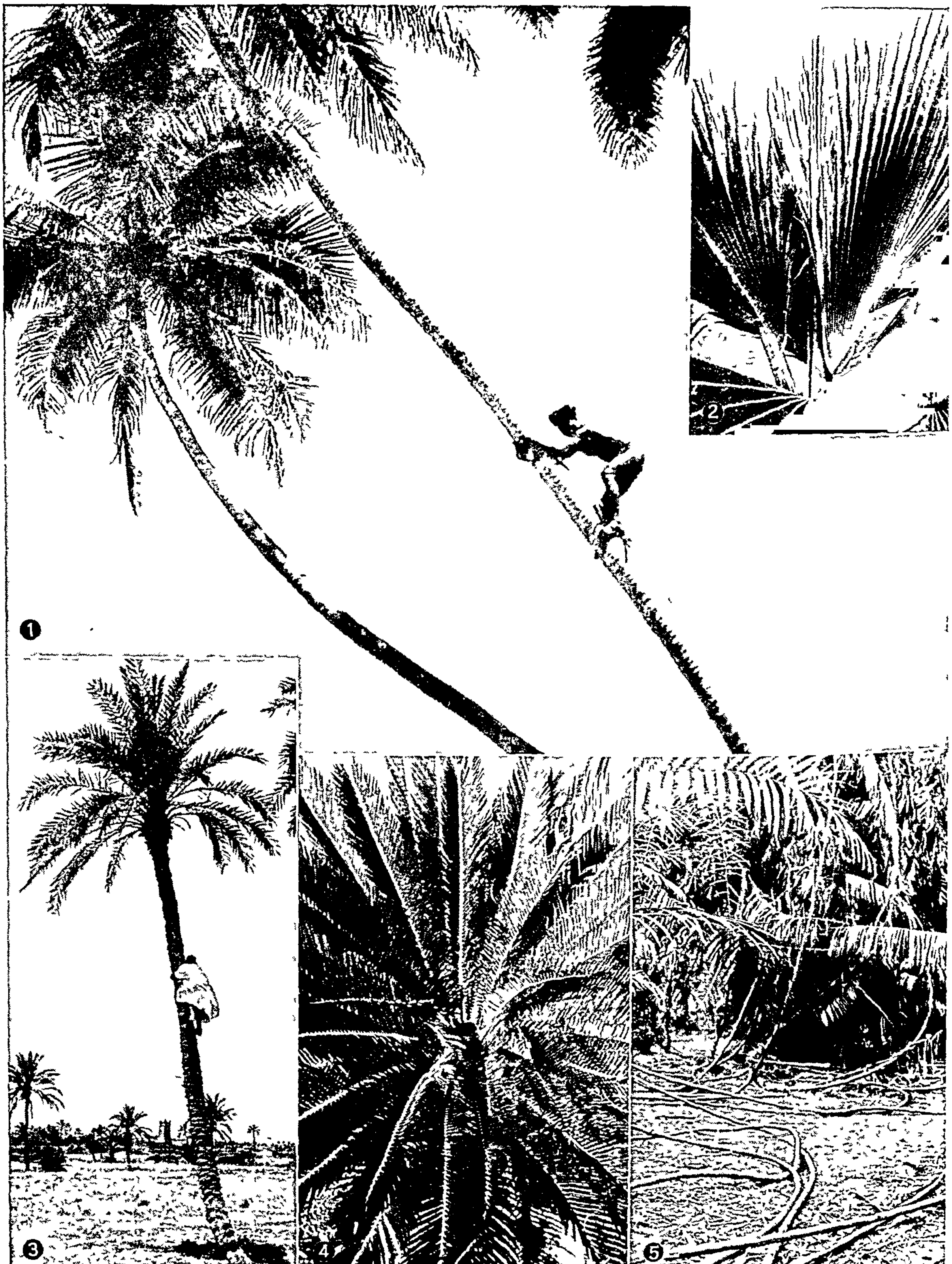
Palms grow in tropical or subtropical climates. Some kinds grow in warmer parts of the temperate zone. The United States has palms in California, Arizona, New Mexico, Texas, and the southeastern states. South Carolina is called the "Palmetto State" because of the palmetto, a small fan palm. Some palms, such as the coconut, need ample moisture. But the date palm and many others grow best in dry climates.

Nature of the Palm

Palms belong to a great plant group with grasses, lilies, and orchids. Most palms are trees, with a single, tall stem or trunk. The trunk has a pithy center but no growth rings or bark. The leaves spread out in a crown at the top. They have many narrow blades on a stem. The blades may fan out (palmate leaves) or be arranged like parts of a feather (pinnate leaves). The plant is named from the fan type, because the blades resemble the palm and fingers of a hand. Some leaves may be from 30 to 45 feet long with stem and from 4 to 8 feet wide.

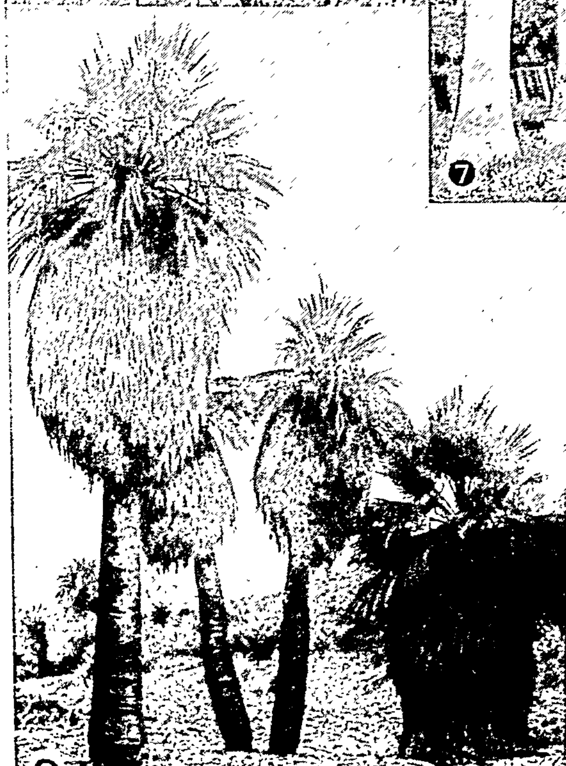
Palms bear flowers in large clusters in the crown of leaves. Each flower is small and usually greenish, yellow, or white in color. While the cluster is budding, it is protected by a special dry leaf, called a *spathe*. Some large, trough-shaped spathes remain in place even when the fruit is formed.

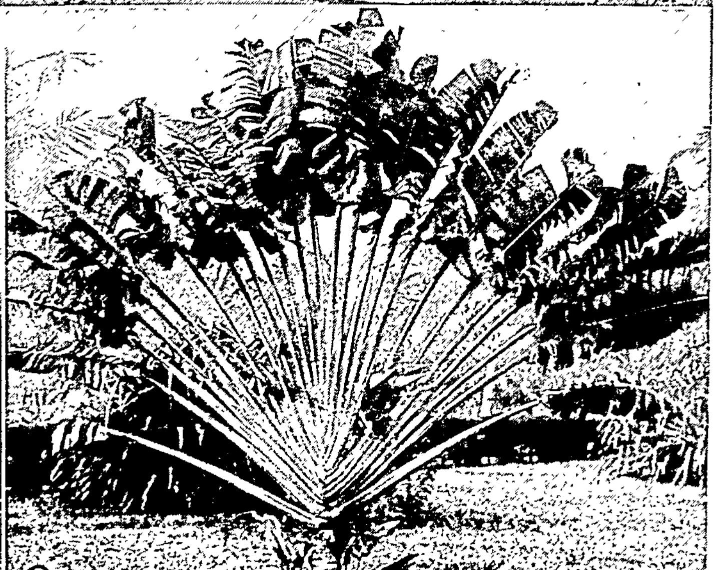
USEFUL PALMS FROM MANY LANDS



1. A native of Ceylon scaling the long, *slender, leaning* trunk of a Coconut Palm. This palm thrives on tropical coasts and islands throughout the world. 2. One of the many Fan Palms from which fans and roof thatching are made. 3. An Arab gathering a meal of dates from a Date Palm in Algeria. 4. Looking down into the heart of a young Sago Palm. The pith of these palms is made into the sago of commerce. 5. Those ropelike stems are Rattan Palms on the island of Java. They run over other trees or along the ground and may grow several hundred feet long. Strips from the stems are woven into ropes, mats, and furniture.

SOME AMERICAN PALMS AND PALM-LIKE TREES





6. A group of Cabbage Palms in Florida. These belong to the species called *Roystonea oleracea*, not to be confused with the cabbage palmettos. 7. An avenue of Royal Palms. This palm (*Roystonea regia*) is a relative of the cabbage palm. 8. These Washington Palms are natives of the southwestern United States. 9. The so-called "Traveler's Palm" or "Traveler's Tree" is not a true palm, but is a relative of the banana from which thirsty wayfarers can get refreshment by tapping the supply of water stored in its base. One species is found in South America, another in Madagascar.

The fruit of some palms are no larger than a pea. But the double or sea coconut may be larger than a man's head. Some fruits, such as dates, are soft outside; others, such as coconuts, have a hard husk.

Palms usually flower when they are five or six years old. Most of them are mature in from 10 to 15 years. The coconut palm and many others bear fruit for 70 or 80 years. Some date palms have lived 150 years.

A few kinds of palms are not trees. Shrublike palms have extremely short stems, and the crown of leaves springs from the ground level. We use these kinds as potted palms. Dwarf palmettos and many other palms have thorny or prickly leaves or stems. Rattan or cane palms have ropelike stems with hooks. These stems climb like vines among other trees.

Valuable Products from Palms

The most valuable palm is the coconut. The meat and milklike liquid provide food. The dried meat (*copra*) yields oil, and the husks provide a coarse fiber, called *coir* (*see* Coconut Palm). The date palm provides vegetable food for many desert peoples (*see* Date Palm). Another important food from palms is sago (*see* Sago). Oriental peoples chew nuts from the betel palm (*see* Betel). The "palm cabbage" of the West Indies is the terminal bud of new leaves at the tip of certain palms.

Palm oil from fruits of the oil palm is widely used. It contains a precursor of vitamin A. The sweet juice of some palms is made into sugar or wine. Nuts from the tagua palm supply vegetable ivory; carnauba palm leaves yield wax. The vinelike stems of the rattan palm and the leaf stems of the raffia (*piassava*) palm yield fiber for basketry, mats, and brushes.

Palms form the family *Palmaceae* of plants (Monocotyledonae) which have single-lobed seeds (*see* Botany). Varying classifications recognize from 128 to 200 genera and from 1,200 to 4,000 species. Scientific names of important palms: cabbage, *Roystonea oleracea;* cabbage palmetto, *Sabal palmetto;* coconut (ornamental, U. S.), *Cocos plumosa;* fan (Chinese), *Livistona chinensis;* ivory (tagua nut), *Phytelephas macrocarpa;* oil (African), *Elaeis guineensis;* palmetto (several species), *Sabal;* raffia (several species), *Raphia;* rattan (cane), *Calamus* (several species); royal, *Roystonea regia;* Washington, *Washingtonia filifera.*

PALMYRA (*păl-mī'ra*), **SYRIA.** Out on the Syrian desert, 150 miles northeast of Damascus, you will see an oasis, a small town, an air field, and a pipe-line pumping station. This is modern Palmyra, a shrunken remnant of a great city of ancient times.

Palmyra is the Tadmor of the Bible, said to have been founded by Solomon. Before the Christian Era, the city was a trading post on the camel route between the East and the Mediterranean world. But its real glory came after the Romans captured it in A.D. 130. They made it the headquarters of a colony and an outpost against the revival of a Persian empire. In 262, Odenathus, ruler of Palmyra, rendered such valuable military assistance that he received the title of Augustus, and Palmyra became virtually independent again. But the glory of Odenathus was short-lived, for he was assassinated about 267.

Zenobia, the dead ruler's able and energetic widow, took over the reins of government for her young son, Athenodorus. She extended her domain until it reached from Egypt to Mesopotamia. At length, however, she came into conflict with Rome, and her armies were defeated by the soldier-emperor Aurelian, and Palmyra fell in the year 273. Zenobia was taken away in chains. Her subjects were spared and Aurelian departed for home. But when he heard that the Palmyrenes had revolted and slaughtered his garrison, he returned swiftly and destroyed the city. Thereafter the caravans took other routes.

Today magnificent ruins rise from the desert in mute and lonely testimony to the glory of the past. You can see the street traversed by the ancient camel caravans, flanked for nearly a mile by a great quadruple colonnade of rosy-white limestone leading to a triumphal arch. Beyond, upon a terrace, stood the Temple of the Sun, its court surrounded by pillars intricately carved. And you can still see the remains of a theater, an aqueduct, the senate house, beautiful villas, and tower tombs as high as eight stories.

Palmyra served as a military outpost during the French mandate over Syria after the first World War. Today the only native inhabitants are Arabs living in hovels amid the ruins.

PAN. In Greek mythology there is perhaps no more picturesque figure than Pan, the god of flocks and pastures, of fields and forests. He is represented as having horns, a goat's beard, pointed ears, a tail, and goat's feet. He led a merry life, dwelling in caves, wandering through wood and dale and over the mountains, protecting flocks, hunting and fishing, and dancing with the nymphs. He fell in love with the beautiful nymph Syrinx, the legend relates, but frightened at his appearance, she fled from him and was transformed into a reed. From this reed the god made the instrument known as the syrinx or Pan's pipes.

The mischievous Pan took delight in coming upon travelers unexpectedly and exciting the sudden fear which has come to be called "panic." He is often represented as accompanied by roguish, goatlike beings much like himself, called satyrs. These were the fauns of Roman mythology, the companions of Faunus, who occupied a position similar to that of Pan. The worship of Pan was introduced into Athens from Arcadia about the time of the Persian Wars, because of his supposed aid to the Athenians in the battle of Marathon.

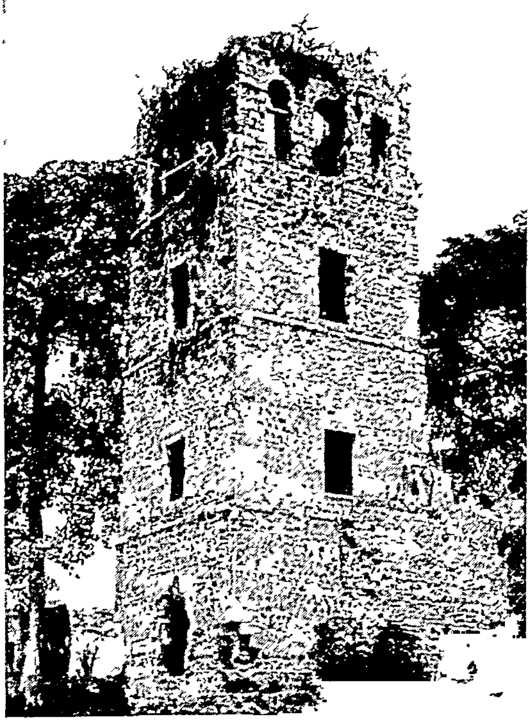
In later times Pan came to be regarded as the god of universal nature, through confusion of his name with another Greek word meaning "all," and finally came to stand for all the Greek gods, and for paganism itself. So a legend arose that when Christ was born, a mighty voice proclaimed through the isles of Greece, "The great Pan is dead!" Thus was heralded the end of the power of the old divinities and the beginning of the new faith.

Pan, dancing and playing his pipes, is a familiar figure in painting and sculpture. The so-called Satyr or Faun, attributed to the sculptor Praxiteles, inspired Hawthorne's novel 'The Marble Faun'.

The REPUBLIC *at the Crossroads of the* NEW WORLD

PANAMA (*păn-ȧ-mä′*), REPUBLIC OF. For more than four centuries the isthmus which is now the Republic of Panama has been the crossroads of the New World. Upon the narrow stretch of jungle which here separates the Atlantic from the Pacific and North from South America has rested the fate of fortunes and empires in the Western Hemisphere.

RELIC OF BUCCANEER DAYS



This tower was almost all that remained of Panama City after it was looted and burned by Sir Henry Morgan, the English pirate, in 1671. Two years later the town was rebuilt five miles west of the old site, which is now only a tourist attraction.

When Spain ruled the Americas, a mere rock-paved trail linked the oceans, but over it passed the fabulous wealth in gold and silver won by the Spanish conquerors. Gold was again the motive when centuries later the isthmus was spanned by a railway to transport prospectors to California. Not gold or silver but trade wrote the final chapter in this story—the construction by the United States government of a canal cutting apart the continents and uniting the oceans (*see* Panama Canal).

A Long, Narrow Country

Panama's stirring past is thus the natural outcome of its commanding location. In size, this little Central American republic, with an area of 28,576 square miles, is not as large as Maine. It stretches like a caterpillar from Costa Rica to Colombia—its greatest length 480 miles, its width ranging from 31 to 100 miles. Its northern shores are washed by the Caribbean Sea and its southern by the Pacific. Off the long curving coast line, 1,244 miles in length, are many scattered islands, chiefly the Pearl Islands in the Pacific, and in the Caribbean, the San Blas group (known officially as the Archipiélago de las Mulatas). The country is cut in two by the Canal Zone, a strip of land five miles wide on each side of the Panama Canal, over which the United States exercises jurisdiction.

Low forest-covered mountains enclose broad valleys and plains in most of the country, though some peaks at the Costa Rican border are more than 11,000 feet high. There are no natural lakes, but many small rivers and streams. The climate is hot and wet. Except at the higher altitudes, there is little variation from the average annual temperature of 80° F. The rainy season is from April to January, with the heaviest downpour along the Caribbean coast, where the rainfall averages 140 inches a year.

The combination of heat, rain, and naturally rich soil has produced thick jungles in the lowlands. Despite their riotous beauty and immense fertility, these jungles were a deadly menace to life until the United States introduced sanitary measures which almost wiped out tropical diseases.

Products and Trade

More than half the republic is uninhabited and almost an unexplored wilderness, and of the rest only a small part is under cultivation. Bananas grown on great plantations along the coasts are the major crop and the chief export. Coconuts, cacao, coffee, sugar cane, and tobacco are also leading agricultural products. Excellent pasture lands support an extensive live-stock industry. The forests yield an abundance of cabinet, dye, and building woods, as well as increasing amounts of rubber.

Gold was mined before the Spanish conquest, and it still is; other mineral deposits, such as manganese, silver, aluminum, and copper, have been little exploited. Magnificent pearls have been obtained for centuries from the Pearl Islands. Coral, sponges, mother-of-pearl, and tortoise shell are other treasures garnered from the sea. Manufacturing is limited largely to sugar refining. Transportation also is little developed.

Trade with the United States usually accounts for more than half of Panama's imports and more than three-fourths of its exports by value. An odd source of revenue is the large number of foreign-owned merchant vessels which fly the flag of Panama in order to benefit from the country's low registration fees. At the outbreak of the European war in 1939, many merchant ships of the United States were registered in Panama to escape American neutrality laws prohibiting them from entering the ports of belligerent nations.

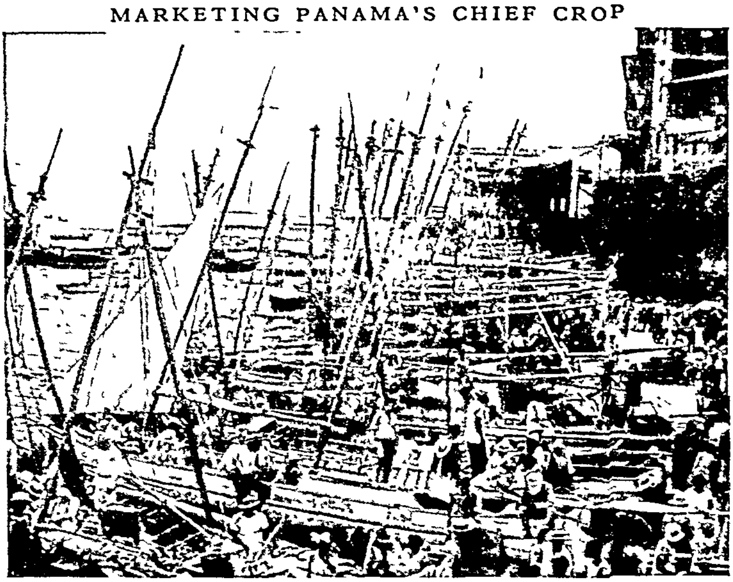
Panama City and Other Towns

On the Pacific, inside the Canal Zone, is Panama City, the nation's capital and largest city. Founded in 1519, it is the oldest settlement on the American mainland. For centuries it was the clearinghouse and stronghold of Spain's empire in the New World. Today, through its port of Balboa, it is one of the world's greatest shipping centers. Though the churches and other old buildings preserve the ancient charm, the city is modern. Its population (1950 census) is 127,874.

Colón (52,204), next largest city and port, is also within the Canal Zone. In both cities, though they

are under the jurisdiction of the republic, sanitation is controlled by the United States, which has made them among the most healthful in the tropics. Colón was founded in 1850 by Americans who chose this site as the Atlantic terminus of a railway they were building to Panama City. Porto Bello, now virtually uninhabited, was the scene of wild adventures in the days when, linked to the Pacific by the "gold road," it was the Atlantic port for shipment of Spanish plunder.

MARKETING PANAMA'S CHIEF CROP



At this busy market in Panama City, natives are unloading bananas, grown on the plantations along the coast and transported by these little fishing sloops to the city. In an average year, nearly 6,000,000 bunches of bananas are exported, mostly to the United States.

The People and Their Culture

Of the 805,285 people (1950 census), about 15 per cent are whites, 15 per cent Negroes, and less than 10 per cent Indians. The *mestizos*, of mixed white, Indian, and Negro blood, constitute more than half of the people. Efforts to settle Europeans on the land have met with little success, chiefly because of the tropical climate. In Panama, unlike many other Latin American countries, foreign control of resources is not great. The whites live on the big plantations and in the towns, and the land is worked in rather primitive fashion by native labor.

The language is Spanish, but English is spoken by many businessmen. Catholicism is the religion of the majority of the people. Education is compulsory up to the age of 15 years, but about half of the people still cannot read or write. There is a National University in Panama City.

Its History—a Saga of Transportation

In 1502 Columbus, on his fourth voyage to the New World, explored the Caribbean coast of Panama in search of a water route to the Orient. In 1513 Balboa, also in the service of Spain, hacked a path through the isthmus jungles to discover the Pacific. Three years later Pedrarias Dávila, the governor of the colony, gave it the name Panama from an Indian phrase meaning "abundance of fish."

As the main highway of Spain's New World Empire, Panama played a dominant, stirring rôle in colonial history. First it was contained in the viceroyalty of Peru, then (1718) in the viceroyalty of New Granada, which included Colombia. When Colombia freed itself from Spain, Panama in 1821 became part of the newly created republic. Despite a vigorous movement for independence, Panama remained under the rule of Colombia until 1903.

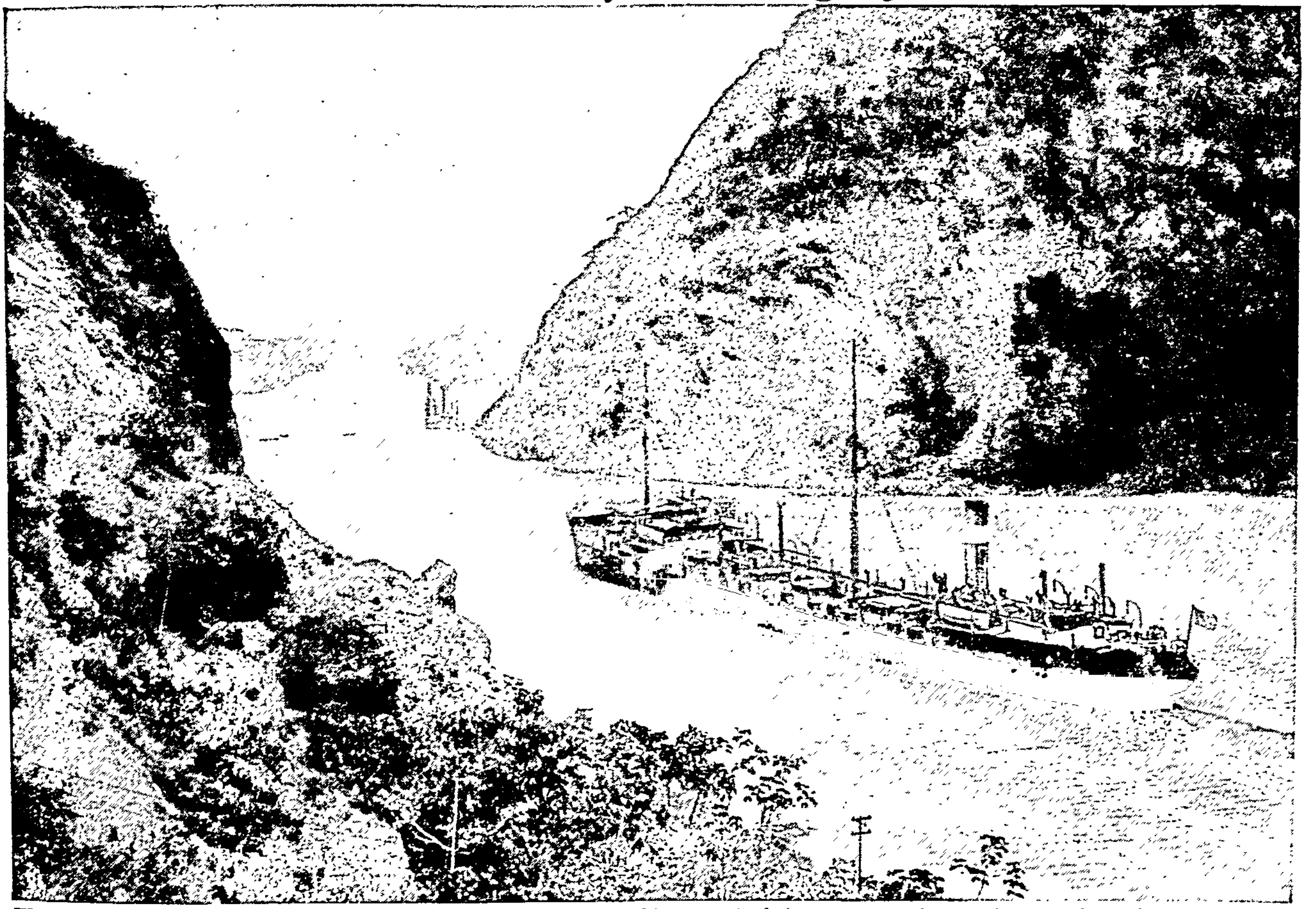
That year, on November 3, the people of Panama declared their independence. Their revolt followed Colombia's refusal to permit the United States to take over from a French company the building of a canal across the isthmus. President Theodore Roosevelt quickly recognized the new republic. On November 18 the two countries concluded a treaty authorizing the transfer of the French rights and allowing the United States to administer the Canal Zone. Panama received the $10,000,000 which Colombia had considered insufficient, as well as annual payments of $250,000 (beginning in 1913). Colombia charged that President Roosevelt had violated neutrality in fostering Panama's revolution. It requested, and later received, an indemnity from the United States. (*See* Colombia.)

Under the treaty of 1903, the United States guaranteed Panama's independence. At Panama's behest, this pledge was eliminated in a supplementary treaty concluded between the two nations in 1939. Nevertheless, the United States was granted the right to take whatever steps were necessary to defend the Panama Canal. Under this treaty the United States established air bases outside the Canal Zone, built a concrete military road ocean to ocean from Panama City to Colón, and ran a pipe line from Cristobal to Balboa to carry fuel for the navy. In 1949 the United States gave the military road to Panama, thus furnishing the little country with its first transcontinental highway. (*See also* Central America; Latin America.)

STREET IN THE OLD FRENCH QUARTER

The Old World atmosphere of Panama City is preserved in the architecture of buildings like these. From the trellised balconies, one might imagine this a town in Spain or France.

The PANAMA CANAL—*from Tragedy to* TRIUMPH



Where this ship is floating there once stood a high connecting ridge—part of the great Continental Divide of the Americas. Now the Panama Canal passes through it. The cleft shown here is called the Gaillard Cut. In the distance is a dredge clearing the channel of the silt that washes down from the steep sides. What this spot looked like while the engineers were at work and before the water was let in, is shown by the photograph on the next page, made from almost exactly the same angle.

PANAMA CANAL. The steaming strip of rugged jungle where the Isthmus of Panama narrows to 30 miles has been for centuries a focal point of world transportation. In ancient geologic times there was a natural channel across here, but the land rose and blocked it. Early Spanish explorers searched the coast eagerly for a strait through which they could sail from the Atlantic to the Pacific. They wanted to go on to the markets of the East Indies, without the long, tedious voyage around the tip of South America.

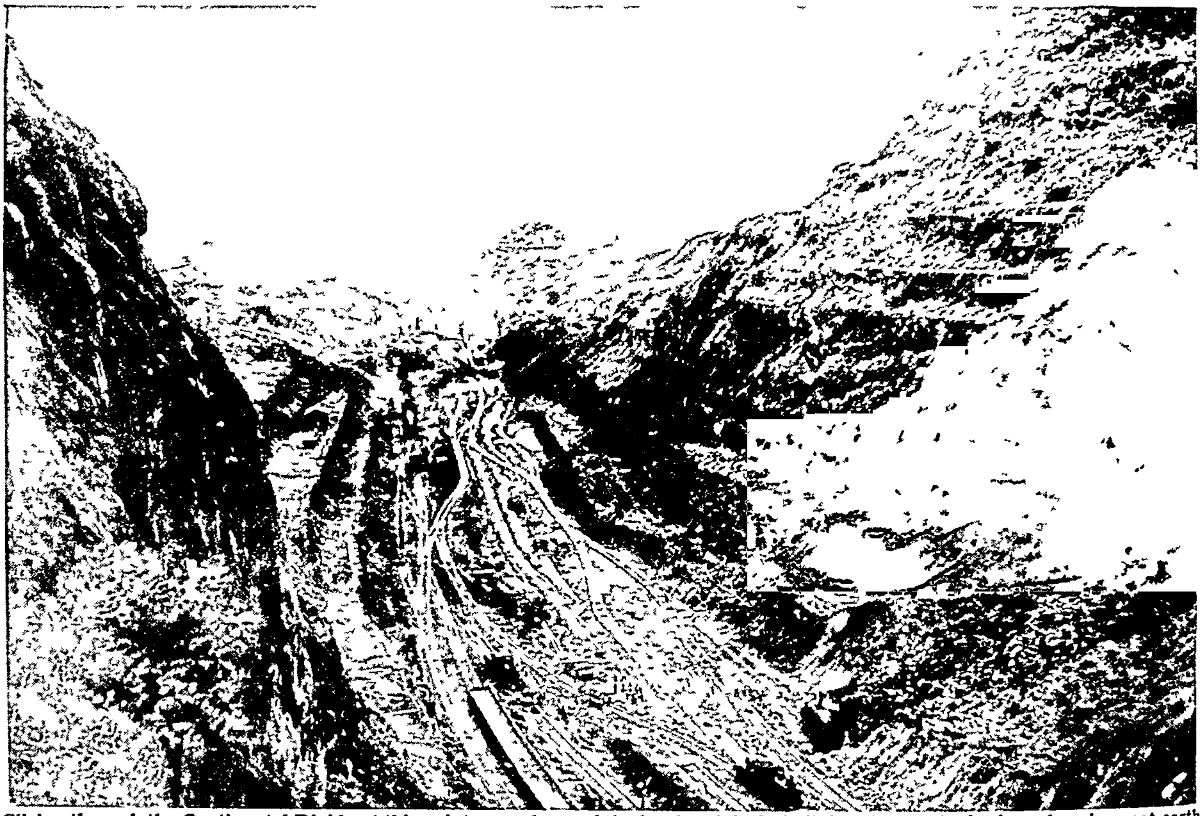
Chief Facts About the Canal

Work begun by the Americans, May 4, 1904; canal opened, Aug. 15, 1914.
Total length of canal, 50.7 miles; bottom width of channel, 300 to 1,000 feet.
Number of locks, 12; length of each, 1,000 feet; width, 110 feet.
Height of Miraflores Lake, 54⅔ feet above sea level; of Gatun Lake, 85 feet above sea level.
Amount of earth and rock excavated before opening of the canal, 239,000,000 cubic yards. Total cost of the canal, including payments to Panama, the French Company, and for sanitation, $375,000,000.
Time needed for vessel to pass through canal, 6 to 8 hours.
Distances saved: New York to San Francisco, 7,878 miles; New York to Yokohama, 3,768 miles; New Orleans to San Francisco, 8,868 miles; Liverpool to San Francisco, 5,666 miles.
Government of Canal Zone: by a governor appointed by the President of the United States, assisted by the heads of the various departments, such as those of operation and maintenance, supply, accounting, and health.

Finding no waterway, the Spaniards soon made the isthmus a land link in their transport of treasure from Peru and other colonies on the west coast of South America. Sailing vessels brought gold and silver to Panama City on the Pacific side. Mule trains carried it over a narrow cobbled trail to Porto Bello or Nombre de Dios on the Caribbean, where galleons waited to freight it across the Atlantic to Spain. This route was faster and safer than the voyage around the Horn. Its rich traffic made Panama a frequent prey of looting pirates. But the dream of a waterway between the oceans persisted.

Flourishing world trade in the 19th century intensified the demand for a quicker, shorter route between East and West. When gold was discovered in California in 1849, there was no transcontinental railroad in the United States. Thousands of people from the eastern states went by ship to Panama, walked across the isthmus, and then embarked again for the gold fields. By 1855 an American-built railroad between Colón and the city of Panama had been completed, on which travelers willingly paid 50 cents a mile. Still the dream persisted of a canal through which the ships themselves could cross from ocean to ocean.

CARVING THROUGH THE MOUNTAIN AT GAILLARD CUT



Slicing through the Continental Divide at this point proved one of the hardest jobs in building the canal. Again and again great earth slides undid the work of months, burying railroad lines and steam shovels. First called the Culebra Cut, it was renamed by President Wilson in 1914 in honor of Lieut. Col. David Gaillard, the engineer who had charge of the excavation.

An obstacle to canal construction greater even than the rocky ridges of the isthmus was the deadly threat of disease. Malaria, yellow fever, and bubonic plague scourged the entire region. Europeans and Americans were particularly susceptible. When the railroad was being built, tropical diseases are said to have killed more than 800 of the workmen.

French Project Ends in Failure

The first to attempt the stupendous task was a French company under Ferdinand de Lesseps, who had completed the Suez Canal in 1869 (*see* Suez Canal). With a concession from the Republic of Colombia, of which the isthmus was then a part, De Lesseps spent two years in surveys. Actual digging began in 1882. By 1889, the project had failed and the company was bankrupt. Disease had thwarted the best efforts of the builders—disease coupled with the mismanagement and dishonesty of the promoters who worked behind De Lesseps' back. A number of French public men were ruined by the scandals of the "Panama Affair."

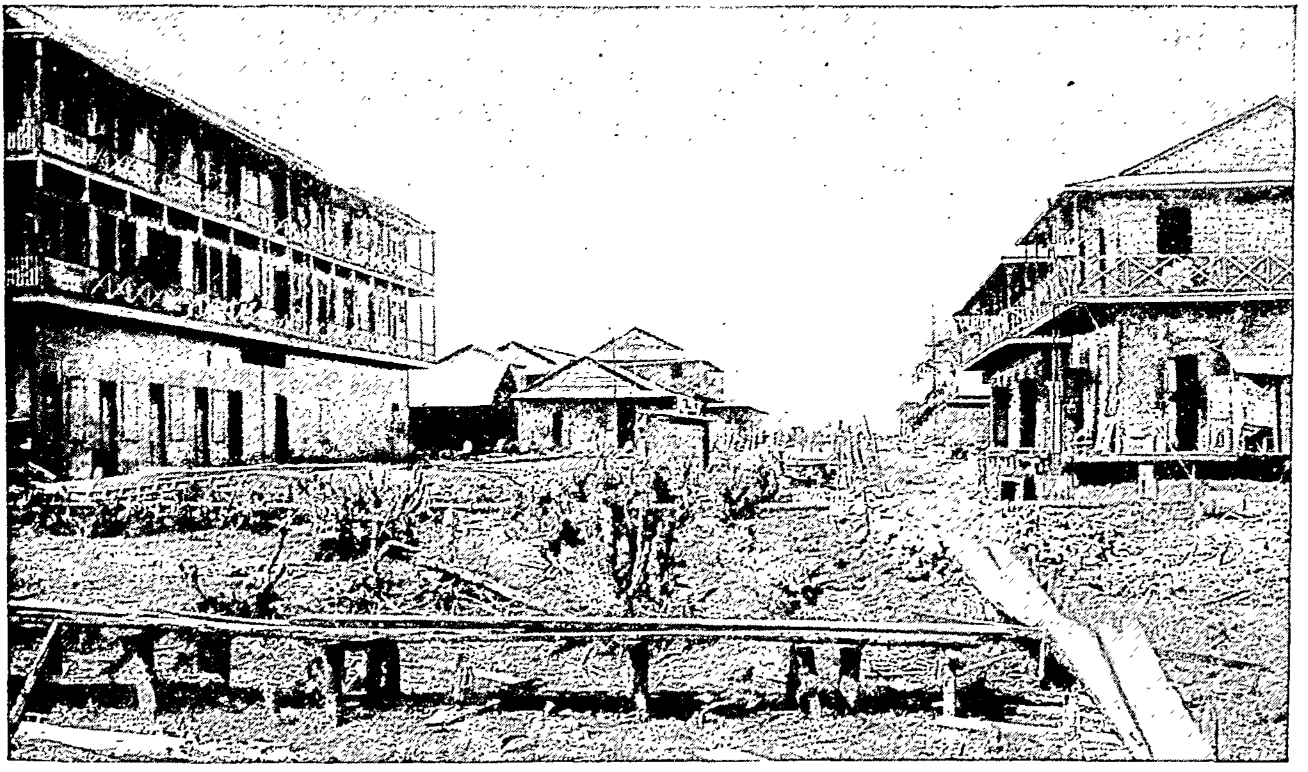
During the seven-year construction period 22,000 men died of disease, although the total of those employed at any one time did not average more than 10,000. Yellow fever alone killed 2,000 of the white men who tried to fill the 1,600 jobs open to them. No man was surprised if the friend he had seen in the morning was lying in his grave at night. Medical men at that time did not know the causes of malaria and yellow fever or that the diseases were carried from patient to patient by the bite of certain mosquitoes. The story goes that the French physicians would stand the legs of the hospital beds in bowls of water to keep out crawling bugs, thus furnishing a breeding place for the deadly mosquitoes right in the sickrooms. Outdoors, every swamp, stream, or pool in this hot, rainy region spawned new swarms.

The United States Undertakes a Gigantic Task

Meantime the interest of the United States government in the canal project had quickened. The senate had ratified the Clayton-Bulwer Treaty with Great Britain in 1850 providing for the neutrality of such a canal whenever it was built. Surveys had been made of various routes, and opinion was divided between Panama and the longer route by way of Lake Nicaragua. The Spanish-American War had focused attention on the need for a faster way to move warships between the Atlantic and the Pacific.

The withdrawal of the French Panama Canal company directed attention anew to the Panama route. In February 1903 the United States paid the French company $40,000,000 for its property and rights. It failed, however, to reach an agreement with Colombia. Panama then declared itself independent. In November 1903 Panama signed a treaty with the United States granting in perpetuity the use, occupation, and adminis-

CLEANING UP THE CITY OF COLÓN



One of the first tasks of the American engineers was to clean up the towns. These two photographs show the same section of Tenth Street, Colón before and after paving. Paving the streets not only made traffic easy, but it gave the city a new appearance and made the residents eager to keep clean.

Gorgas, the American army doctor, commanded the fight for health. He drained every ditch and pond that could be drained, and over those that could not be drained he spread a film of oil which killed the mosquito larvae. He destroyed all vermin, burned all rubbish, screened windows, doors, and porches; provided sewage disposal and a pure water supply. From one of the most unhealthful spots in the world, the Canal Zone became one of the most healthful. The death rate for employees during the ten years of construction work was only 1.7 per cent. Continued sanitary activities since the opening of the canal had dropped the death rate to 0.6 per cent within a quarter century. This record set an example that has led to better health in other tropical regions.

tration of a strip of land ten miles wide (the Canal Zone). The United States paid $10,000,000 and agreed to make yearly payments of $250,000 (*see* Panama). In 1939, after the devaluation of the dollar, the yearly payment was fixed at 430,000 Panamanian balboas.

To two United States Army colonels goes credit for achieving success where the French had failed. Colonel George Washington Goethals, as engineer in chief after 1907, directed construction. Colonel William Crawford Gorgas of the Medical Corps, as chief sanitary officer, led the battle against disease. Later, both became major generals (*see* Goethals; Gorgas).

The United States took possession of the canal property on May 4, 1904, and the first two and one-half years were given over to the careful preparation that brought health, efficiency, and speed when actual construction started.

Gorgas Conquers the Mosquito

Since the days of the French adventure, two medical discoveries had been made that prepared the way for the achievement of Colonel Gorgas. In 1898 Dr. Ronald Ross, an English army surgeon, had discovered that malaria is conveyed by the bite of the *Anopheles* mosquito. In 1901 Dr. Walter Reed, a surgeon in the United States Army, and his associates had proved that yellow fever is passed from man to man by the *Aëdes* mosquito (*see* Mosquito). Gorgas himself, while serving as chief sanitary officer in Havana, Cuba, had directed the development of practical methods of sanitation based on these discoveries. With this invaluable knowledge and experience as guides, he set to work to make the Canal Zone a safe place for men to work—a safe place for them to live and rear their families.

He drained every lake, swamp, pond, and ditch that could be drained. Over those that could not be drained, he spread a film of oil to destroy mosquito eggs and larvae. He cut grass jungles to the ground, destroyed vermin, and burned rubbish. He raised all buildings above the ground, and screened windows, doors, and porches with fine wire screens, and ordered householders to cover all vessels that held water. He screened every train, and on every train he put a hospital car. He built hospitals for isolation and treatment. Cities were given sewers and pure water.

Ships coming from disease-ridden areas were placed under strict quarantine. To guard against bubonic plague, rats and fleas were killed and houses made rat-proof.

Gorgas began his work in May 1904. In May 1906 the last case of yellow fever occurred in Panama. The conquest of malaria was slower, but the number of cases dropped year by year. By 1914, when the canal was opened, only 82 out of each 1,000 employees went to the hospital with malaria. During that year only seven employees died of the disease. With an average of 39,000 employees during the ten years, the deaths from all causes averaged only 663 each year. This death rate of 17 per thousand was lower than that of many American cities of that period.

Here was one of the most impressive victories ever won by science against disease, and the cost of all the sanitary measures involved amounted to about one cent a day for each inhabitant.

Recruiting Labor, Assembling Machines

Preparations for construction were carried on under the supervision of the Isthmian Canal Commission, appointed by President Theodore Roosevelt, with John F. Stevens as chief engineer. To recruit the large working force required, the commission set up agencies in the United States, Europe, and the West Indies. Meanwhile, buildings were started and equipment assembled to house, feed, and safeguard the men recruited. Unskilled or semi-skilled workers were paid in silver coin, while the skilled craftsmen and those occupying executive, professional, and higher clerical positions were paid in gold. This classification of workers into "silver" and "gold" employees has persisted since the canal has been in operation, though all are now paid in paper money.

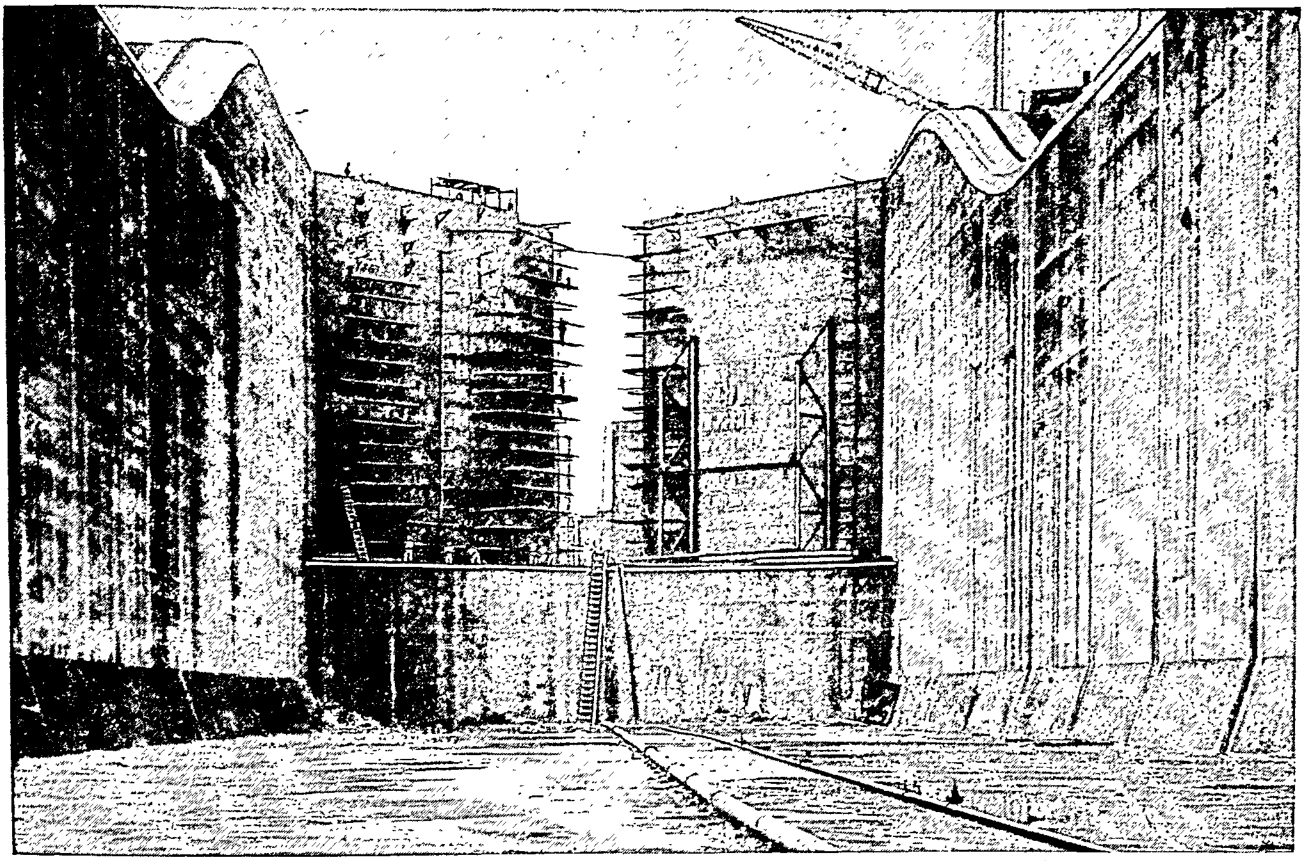
The construction equipment that had to be assembled included mammoth steam shovels, locomotives, track-shifters, pile drivers, dredges, steamboats, and tugs. The railway had to be reorganized. A civil government for the Canal Zone had to be established, with courts, police force, fire companies, customs and revenue service, and a postal system.

Goethals Directs the Battle of the Builders

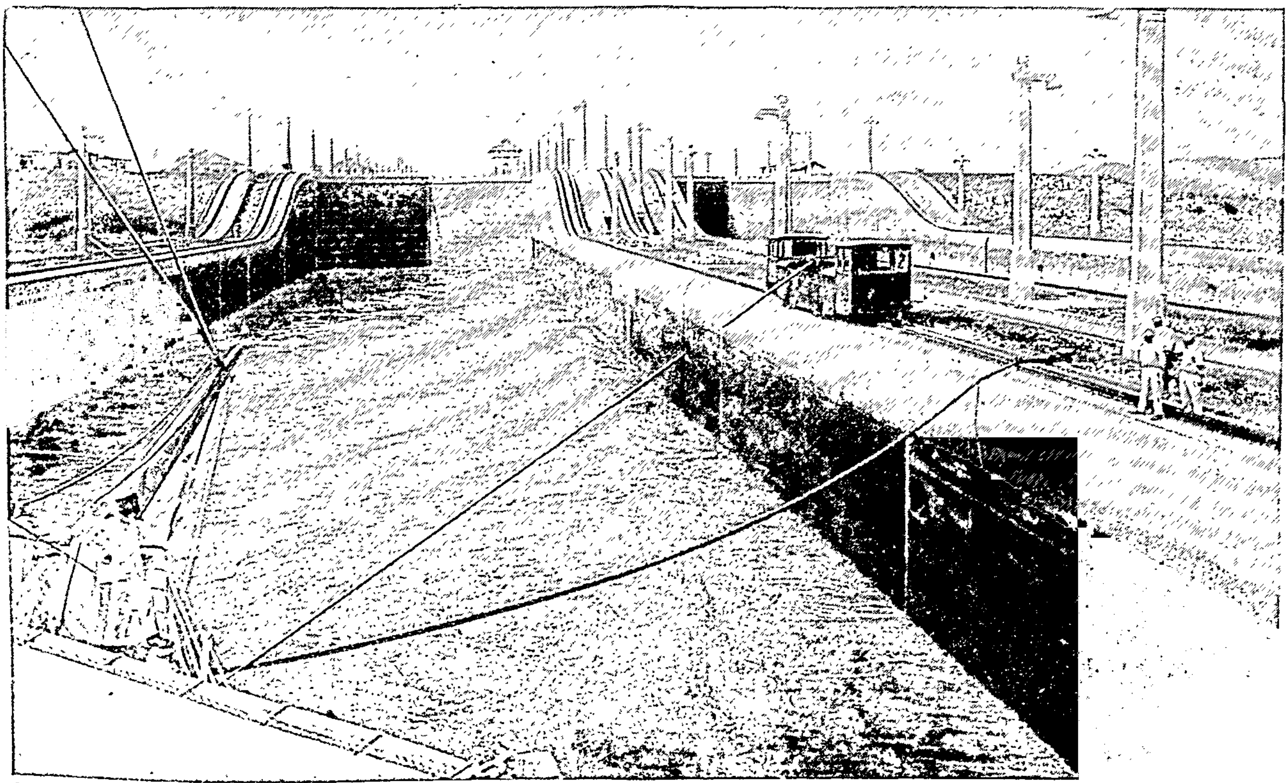
In 1907 Stevens resigned, and President Roosevelt appointed Colonel Goethals chief engineer and chairman of the Canal Commission. He had complete control of construction. From then on the work was to be done by the government under army supervision, instead of by private contractors as previously planned.

For the next seven years an observer in the Canal Zone could have seen such a sight as the world perhaps had never witnessed since the building of the Pyramids or the Great Wall of China. The tropical sun beat down upon a 40-mile long panorama of industry. Swarming in the mighty cuts were legions of sweating laborers, white and black, some in shirt sleeves, some almost naked. Some toiled with pick, shovel, and crowbar; others with drill and dynamite in the stone cuts. Series of cableways and a network of railway tracks ran everywhere. Mighty derricks and cranes swung huge buckets of concrete through the air and lowered them into the forms to build locks and embankments. Powerful drills bored holes into solid rock at the rate of seven feet an hour. The arms of monster dipper dredges rose and fell from barges afloat in swamps and bays. More than 100 steam shovels doing the work of 10,000 men dug up earth in ten-ton scoopfuls and dumped it into waiting railroad cars. One hundred and fifteen locomotives hauled trains of these cars to the dumps, where a great plow traveled from one end of the train to the other unloading 20 cars, each carrying 60 tons, in less than ten minutes. The earth which was excavated amounted to more than 220 million cubic yards, which would make a line of 63 pyramids, each the size of the Great

THE GIANT LOCKS AT GATUN



This picture, taken while the lock was under construction, gives you a good idea of the tremendous size of the structure. The chamber is 1,000 feet long and 110 feet wide. The gates at the end are 7 feet thick and 76 feet high.



Electric locomotives draw the ships through, thus avoiding the danger of damage to the locks, which would be almost certain if ships were allowed to proceed under their own power. This ship has entered the lock from the Atlantic side, and will be raised to the level shown by the blackened sides of the enclosure before proceeding into the next lock.

Pyramid of Egypt. This earth was used in building the Gatun Dam, in filling in low places, and in building breakwaters for the new port of Balboa created at the Pacific outlet of the canal.

The "Water Stairway" over the Ridge

The French had planned a sea-level canal. The United States called upon a commission of internationally known engineers to study the problem. Upon considering their report, it was decided to leave the central section of the canal 85 feet above sea level and to construct a "water stairway" of great locks by which ships could climb up one side of the divide and down the other end.

The French canal's width of only 74 feet would have quickly proved inadequate for modern maritime traffic. The United States plan called for a channel with a minimum width of 300 feet.

It was necessary to make cuts more than 300 feet deep where the canal was to cross the Continental Divide. The mountains were blasted away with dynamite in tremendous charges that contained as much as 40,000 pounds at a time. The jungle rocked and echoed from the cannonading of this mighty battle of peace.

There was a strong spirit of competition among the workers of the three great divisions—the Central, Atlantic, and Pacific divisions. Strong men worked like schoolboys to beat the records of their rivals. Behind the stupendous labors of men and machines stood the skilled planning and calculations of the engineers, which made all parts of the work dovetail together into a smoothly operating enterprise. One man designed lock gates as high as a six-story building that worked with the precision of a fine watch. Another invented a special machine to open and close these giant doors.

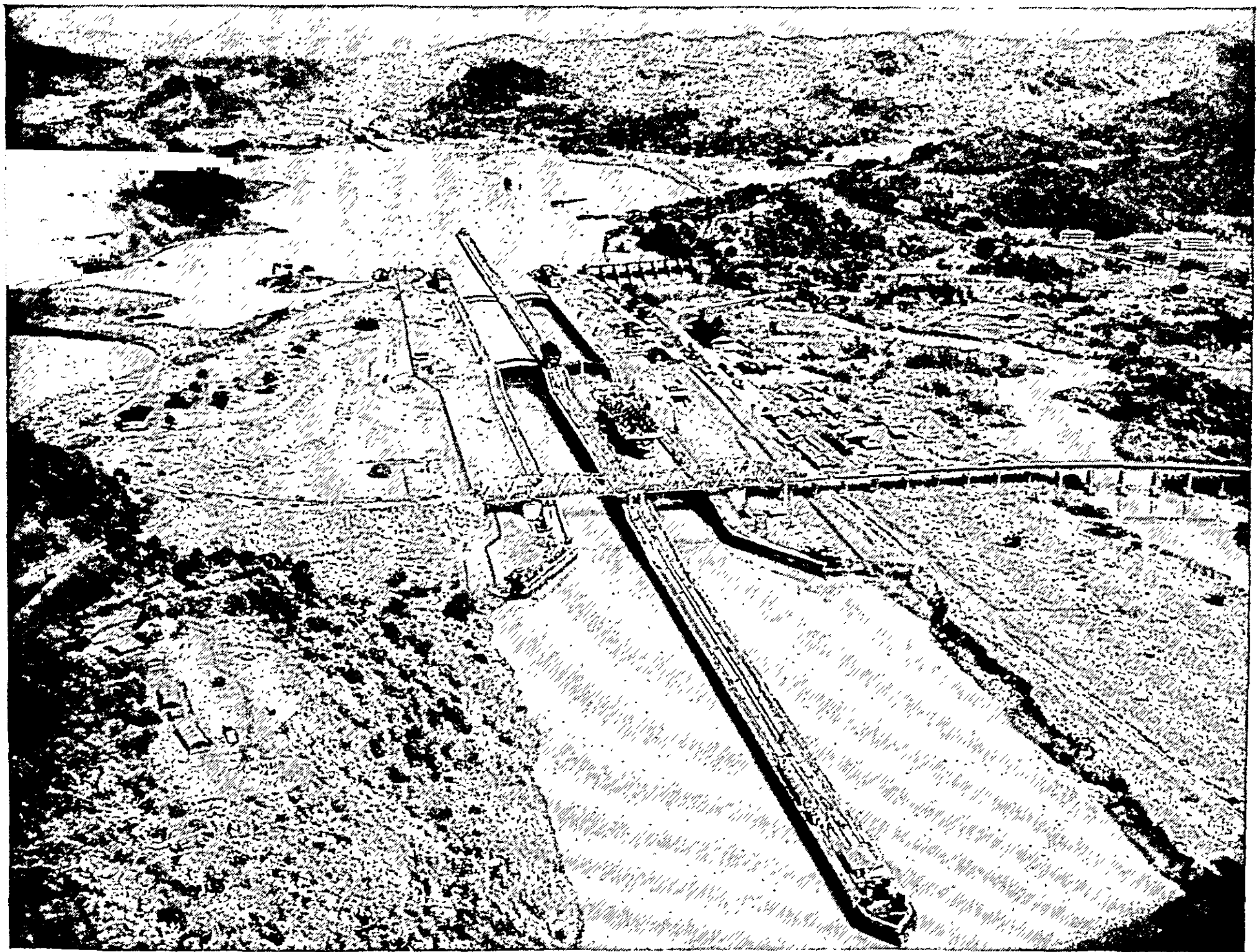
OPENING THE SPILLWAY AT GATUN DAM

At the time of its construction, this was the largest dam in the world It is nearly 1½ miles long measured at the crest, and half a mile thick at the base. At the water level the dam is 400 feet thick. Twenty-five million cubic yards of material were required to build the dam. The concrete spillway shown in the photograph is 1 200 feet long and 300 feet wide, cut through a hill of rock in the center of the dam. It required 225,000 cubic yards of concrete to build the spillway alone This spillway allows the surplus water from Gatun Lake to empty out through the Chagres River.

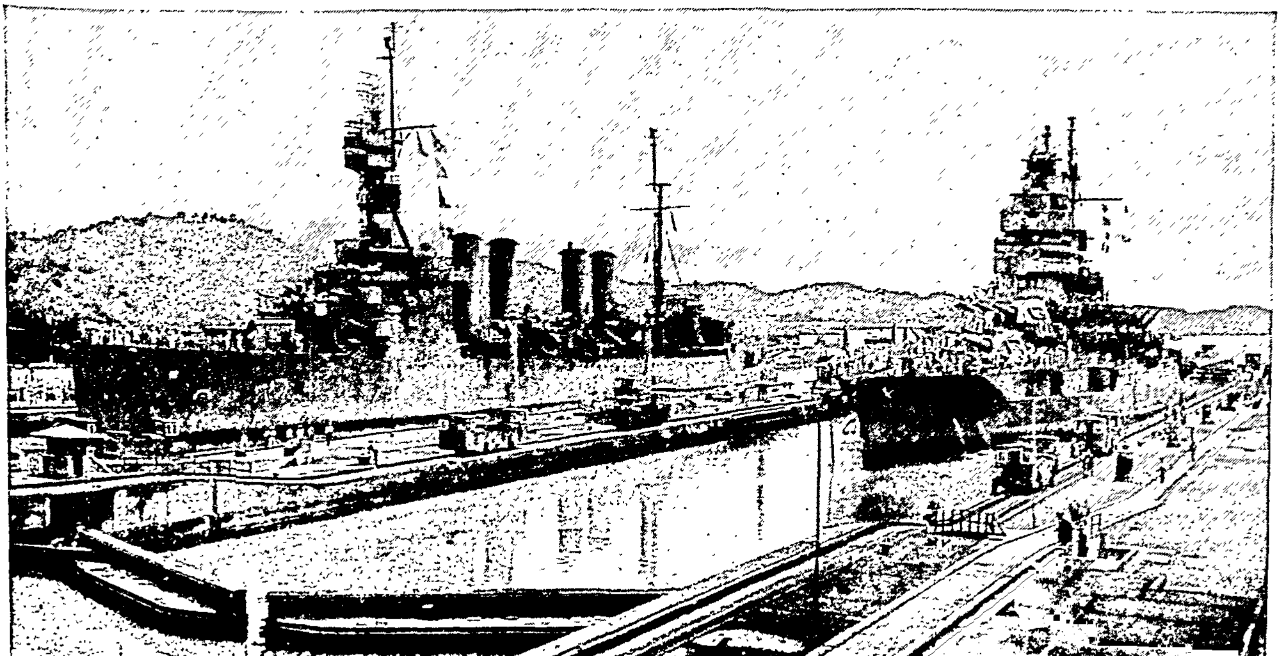
The work progressed in the face of incessant difficulties. Once there was an earthquake. Heavy rains brought terrific landslides in the great Gaillard or Culebra Cut which often undid the work of months. The Chagres River, flowing down the Atlantic side, was particularly troublesome because of its floods, but it was conquered by the construction at Gatun of one of the mightiest dams in the world, made of earth and rock—a structure a mile and a half long, half a mile wide at the base, and 100 feet wide at the top. This dam connects the hills at each side of the Chagres Valley with a hill in the center, creating Gatun Lake, which has an area of about 165 square miles at normal level.

The Opening of the Canal

So for nearly ten years the digging and dredging and building of concrete walls and locks went on. Then on Oct. 10, 1913, President Wilson, 4,000 miles

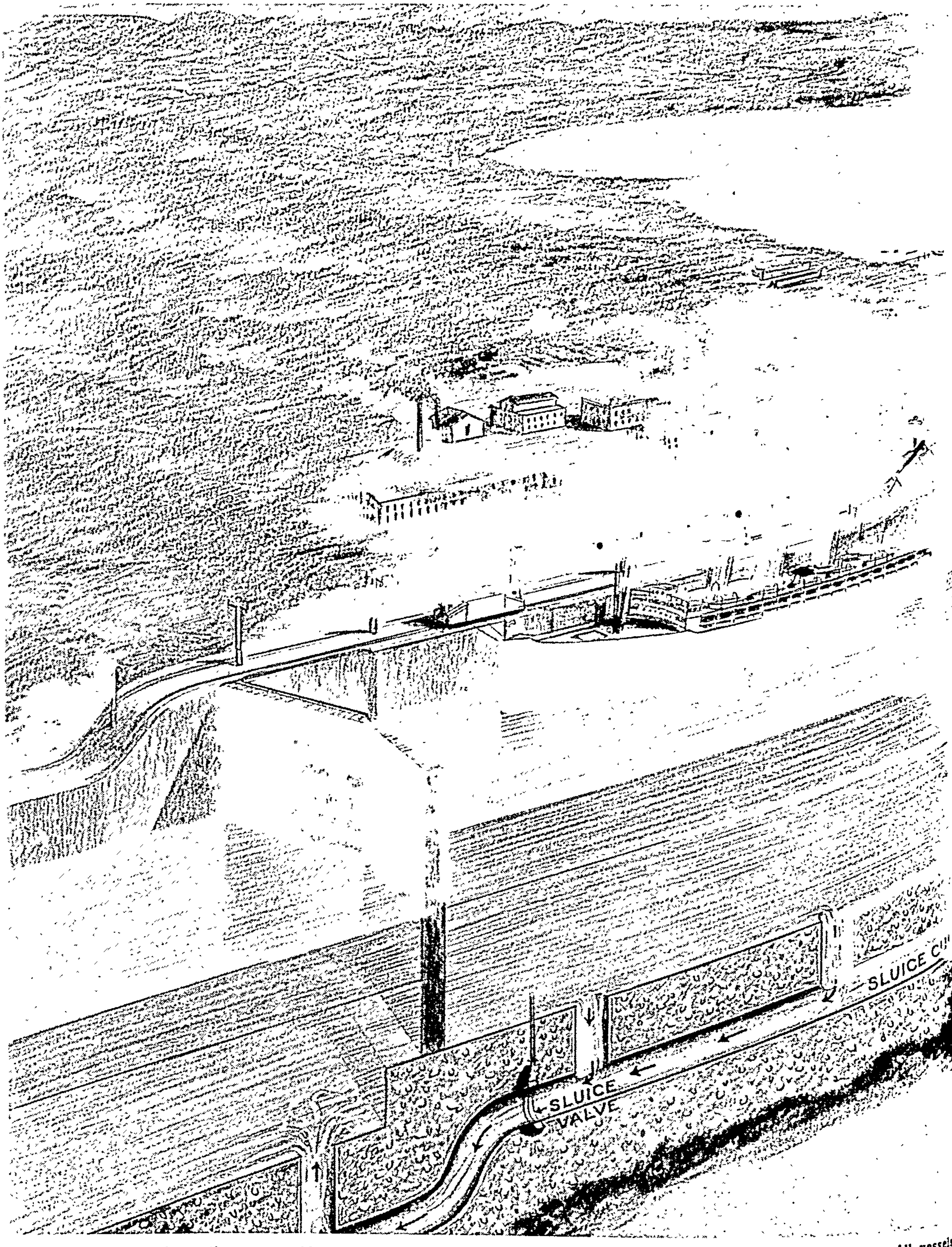


An airplane carrier en route from the Pacific Ocean to the Atlantic moves into Miraflores locks to be lifted to the level of Lake Miraflores. The spillway is at the right of the locks. The swing bridge over the lock approach is a link in the Inter-American Highway—the section of the Pan American Highway in Central America.

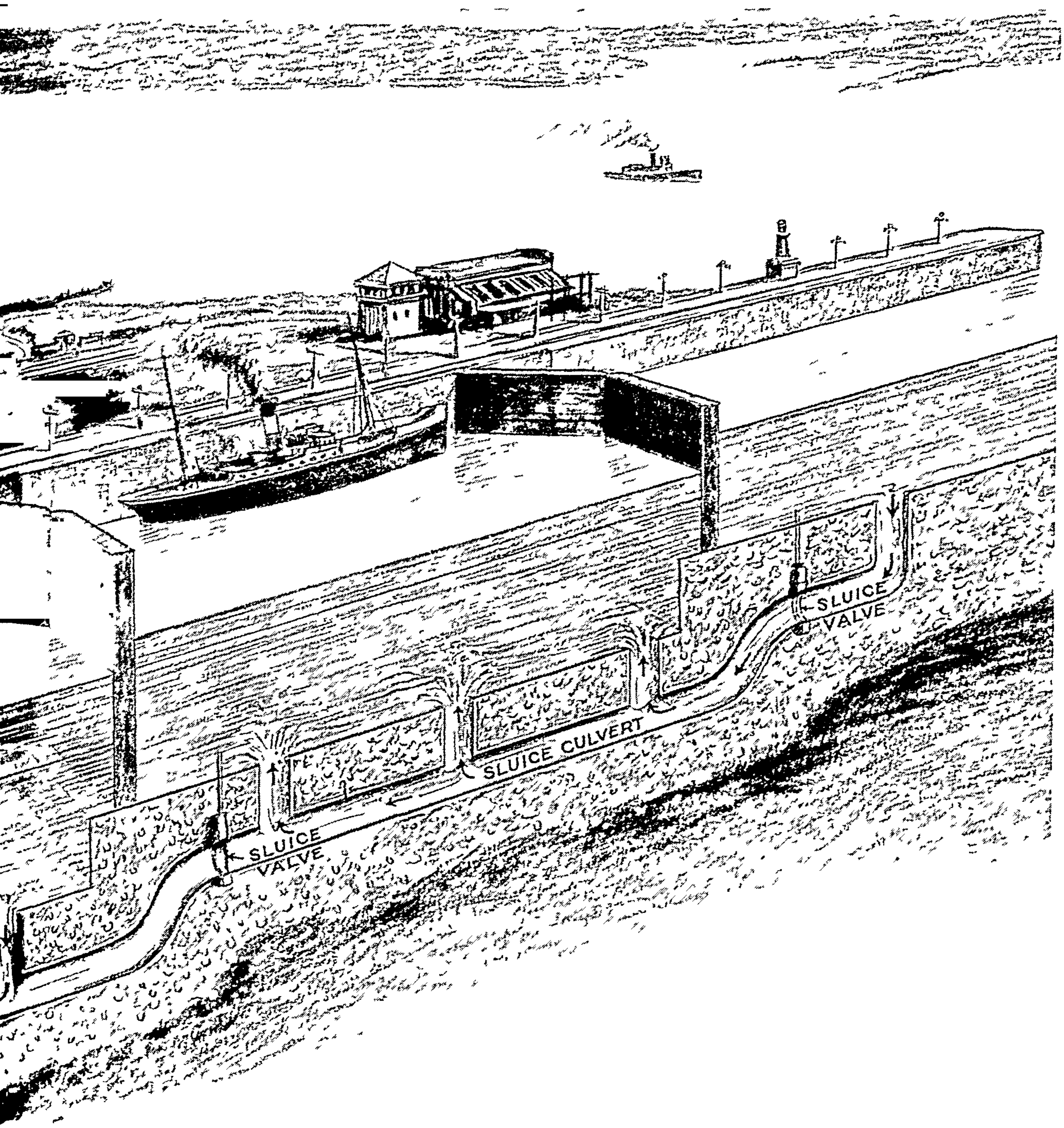


A cruiser (left) and a battleship are being towed by small locomotives through twin locks on the canal. These ships have adequate clearance within the 110-foot-wide chamber. Some huge warships have only a few inches to spare, and several aircraft carriers built during the second World War and later cannot go through the locks.

HOW THE GREAT LOCKS WORK WHICH



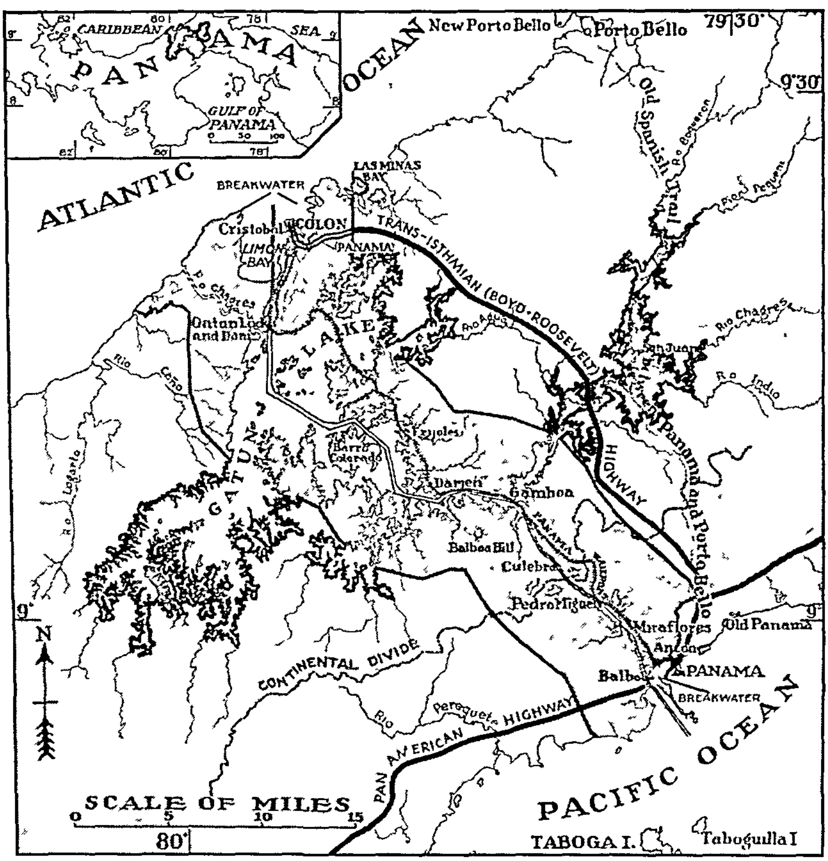
This drawing was made so that you could see the principles which are applied in the operation of the Panama locks. All vessels are towed into and through the locks by electric locomotives, which run on cog-rails laid on the tops of the lock walls. For each flight of locks there are two towing tracks, one on the side and one on the middle wall. Usually four locomotives are required; two ahead, one on each wall, to pull; and two behind, one on each wall, to keep the ship in the center of the lock and to stop it when necessary. Each is equipped with a slip drum and hawser, so that the towing line may be paid out or taken in without actual motion of the



omotive. The locks are filled and emptied through a system of culverts. To fill a lock, the sluice valves at the upper end are ned, and the lower valves closed. The water flows through the culvert and up through the holes in the floor into the lock mber. To empty a lock the upper valves are closed and the lower ones opened. The water then flows out of the lock chamber, ough the culvert, and out into the lower lock or pool. The main culverts under the walls are 18 feet in diameter, while the smaller ones leading under the lock floor are 3½ feet across, allowing a rapid transfer of water.

away in the White House in Washington, pressed an electric button which sent a flash over wires and cables and set off a tremendous charge of dynamite that blew out a temporary dike. A flood rushed through a rock-walled rift in the mountains, and the Panama Canal was a dream realized. The greatest engineering wonder of the world had been achieved

WHERE THE ATLANTIC IS WEST OF THE PACIFIC



This map shows how the Atlantic entrance to the Panama Canal lies west of the entrance from the Pacific. The strange positions arise from the fact that the Isthmus of Panama dips to the southwest at this point, as shown by the small map in the upper left-hand corner. The heavy lines on the large map indicate the boundaries of the Canal Zone. The Trans-Isthmian Highway provides a Panamanian corridor to Colón.

by American engineers at a cost of $375,000,000. The Canal Zone marked the historic day by placing a new motto on its official seal: "A land divided; the oceans united." On Aug. 15, 1914, the canal was opened to world commerce. The first ship through was the government vessel *Ancon*, carrying guests of honor.

After 400 years, the explorers' dream of a westward passage had come true. Science and technology beyond Columbus' wildest imaginings, in the hands of a nation then unborn, had built a water highway to speed great, high-powered ships around a world whose size Balboa never guessed.

The total length of the canal, from deep water to deep water, is about 50 miles; from shore line to shore line it is about 40 miles. The passage requires from six to eight hours, and about 48 ships a day can pass through. Between 5,000 and 6,000 ships use the canal in a normal year, carrying over 25 million tons of cargo. Tolls are charged on net tonnage basis. The average toll is about $4,500. A huge liner pays far more. But in recent years tolls have rarely provided enough revenue to meet operating costs.

What is the "big ditch" like today? Imagine you have taken a steamer at New York, sailed down the Atlantic coast, and across the blue palm-fringed Caribbean Sea to Limon Bay. The harbor is dotted with ships under the flags of a dozen nations. From war vessels to pleasure yachts they take their place in the processions passing into and out of the canal. The Toro breakwater, which extends two or three miles out into the sea as a protection against destructive winds, looms up in front of you, and you steam around it into the canal entrance, where a government pilot boards the ship.

On your right you see the steel-concrete piers, commissary houses, and hospitals of Cristobal (Christopher), the new port of the Canal Zone; on your left the white houses and red roofs of Cristobal's twin city, Colón (Columbus), which along with Panama City flies the flag of the Panama Republic. Past the great bronze statue of Columbus you sail into the canal across the low coastal belt through a channel 500 feet wide and 40 feet deep, the minimum depth of the canal. The tropical forest has been pushed back, but you see it on each side, with its great ferns, delicate creepers, and brilliantly colored birds and blossoms. The shores begin to rise and the waterway to bore into the hills.

You sail seven miles, and suddenly the way is blocked by an enormous wall of concrete masonry, with a double steel gate in the middle. This is the entrance to the first of the three locks at Gatun. The right half of it opens in two leaves, seven feet in thickness and weighing perhaps 600 tons, and in you sail. Then you see that a central concrete partition, 60 feet wide, resembling a boulevard even to the lampposts, divides the canal into two sections, one for incoming, the other for outgoing vessels. (Ships begin the voyage simultaneously from the Atlantic and Pacific.)

The engines of your ship are stopped, and four electric locomotives on cog tracks on the canal walls —which are 50 feet wide at the bottom and 8 feet wide at top—slowly tow the ship into the lock by hawsers made fast to bow and stern. The gates close behind, shutting the vessel into the great chamber. Each lock is 1,000 feet long and 110 feet wide. From

a huge unseen culvert water pours into the lock and your ship slowly rises until it is at the level of the next highest lock; gates open to let you into the next lock. The third lock brings you to the 85-foot level of Gatun Lake, and the engines start again for a run of 24 miles across this great artificial lake.

Through Gatun Lake to the Pacific

Gatun Dam, behind you to the right, holds in the waters of the lake. A spillway with 14 gate-controlled openings lets surplus waters escape into the lower Chagres River. Generators, run by this overflow, supply electric power for operating the machinery of the canal and for lighting the Canal Zone. Farther up the Chagres, and nine miles from the canal, is Madden Dam, which forms another large reservoir built to supply additional water to Gatun Lake and more power for the Zone. It was completed in 1938.

From Gatun Lake you sail into the Gaillard Cut, a great gash through the central divide, more than 300 feet wide at the bottom. Eight miles more and you begin to descend the water stairway. Through one lock at Pedro Miguel the ship drops down about 30 feet to the level of Lake Miraflores, two miles wide; and later two more locks lower you to sea level. From here you can see in the distance the American port of Balboa, on the Pacific side, with oil and coaling plants, dry docks, machine shops, warehouses, and a naval station. A trolley line runs down the coast to Panama City, the gay, quaint old Spanish capital of Panama. Finally you steam eight and one-half miles through a 500-foot channel into the Pacific.

What Does the Canal Accomplish?

This great east-west waterway has been a boon to general world commerce, and of particular value to the commerce of the nations of North and South America. Quicker and cheaper transportation to the markets of eastern North America and of Europe encouraged the development of the rich resources on the western coasts of the New World. Its particular service to nations on the Pacific side of South America has helped to draw closer the bonds of Pan American trade and friendship.

Water distances between Atlantic and Pacific ports of the United States have been more than cut in half. The distance from New York to San Francisco by way of the Strait of Magellan is 13,140 miles; by the canal, it is 5,262. The saving of 7,878 miles amounts to nearly a month's steaming at ordinary cargo ship speed. This saves thousands of dollars in running expense for each ship. Ships traveled 13,551 miles between New Orleans and San Francisco before the canal was opened. Now they travel 4,683 miles.

The canal gives United States ports an advantage in trading with the Orient too. Australia is now nearer to the east coast of the United States than to the north coast of Europe, and Hong Kong is no farther from New York than it is from London.

The benefits of the canal are open in peacetime to all nations of the world on equal terms, in accordance with the Hay-Pauncefote Treaty (*see* McKinley, William). To safeguard the canal, the United States may forbid its use by belligerents in time of war.

Its Strategic Importance and Defense

The canal has immense strategic value. Through it the United States can shift its naval strength quickly from ocean to ocean. Since a well-placed bomb could wreck a dam or lock and block the channel, the defense of the canal is a matter of prime importance. Before the second World War, the defenses were already formidable. Guns guarded both entrances. The Atlantic end was protected by a submarine and naval base at Coco Solo, by outlying naval bases in the Caribbean (*see* Navy), by an Air Force and antiaircraft base at Cristobal, and by an air base at France Field near by. The Pacific end was guarded by an Air Force base at Albrook Field.

In 1939 Congress granted large sums to strengthen these defenses and authorized a third set of canal locks. Plans called for large, single-chamber locks 3,000 feet from the original locks. These plans were not carried out because the locks would have added navigational hazards by requiring ships to turn sharply.

New defense installations reached far out into the Panamanian mainland when the United States entered the war. The jungle concealed air bases, antiaircraft batteries, and listening posts. A highway between Colón and the city of Panama was opened in 1942. The Navy built twin fuel pipe lines from Cristobal to Balboa. New air bases near the Pacific were Howard Field and Rio Hato. Naval and air bases on islands in the Caribbean and in the Pacific provided for a careful patrol of approaches to the canal.

The invention of the atomic bomb raised new canal defense problems. Canal engineers were ordered to make surveys and recommendations. Proposals under investigation included deepening the canal to sea level, thus eliminating vulnerable locks; constructing a second canal in Nicaragua; and completing the third set of locks, begun in 1940.

The Canal Zone. The five-mile strip of land on each side of the canal is a United States military reservation. The government owns all the land and conducts practically all the business and the schools, hospitals, and other community services. In 1951 a federal agency called the Panama Canal Company was authorized to operate the canal, the railroad across the isthmus, and the shipping line. The residents, chiefly canal employees, live cheaply, for prices are low and there are no taxes. Population, both civilian and military (1950 census), 52,822.

PANDO'RA. In Greek legend, Pandora was the first woman on earth. After Prometheus had stolen fire and given it to man, Zeus in anger caused a woman to be made so that man would suffer (*see* Prometheus). Hephaestus fashioned her of clay, and each of the other gods bestowed a gift on her. Aphrodite gave her beauty, Hermes persuasion, and Athena feminine skills. She was named Pandora ("all-gifted").

In one version Zeus gives her a mysterious jar (or box) before sending her to earth. There, Epimetheus ("afterthinker") married her despite a warning from his brother Prometheus ("foresighted") to accept nothing from Zeus. But Epimetheus feared the jar, and he

PANDORA, JUST AFTER SHE OPENED THE JAR

This painting by the German artist, Gabriel von Max, shows Pandora in a seemingly untroubled sleep while evils come forth from that open jar to plague mankind forever. On waking, Pandora replaced the lid. But all the jar's contents, except hope, had gone.

ordered Pandora never to open it. But secretly she removed the lid. Out flew all men's ills and evils and covered the world. Hope alone stayed in the jar.

Another story has it that the jar contained all blessings. These would have been preserved for man, the story goes, had not Pandora out of curiosity opened the jar and allowed all but hope to escape.

As the first woman, as a victim of curiosity and disobedience, and as a bringer of woe to man, Pandora of Greek legend was much like Eve of the Bible.

PANSY. What can be more charming and pleasing than a bed of these flower faces nodding to you as they sway to and fro in the summer breeze? Indeed, they have won the favor of nearly everyone, as you can tell from their quaint and popular nicknames: "cuddle-me-to-you," "jump-up-and-kiss-me," "love-in-idleness," "heartsease," and many others.

The name pansy comes from the French word *pensée*, meaning "thought." As Mary E. Bradley has said in her poem 'Heartsease':

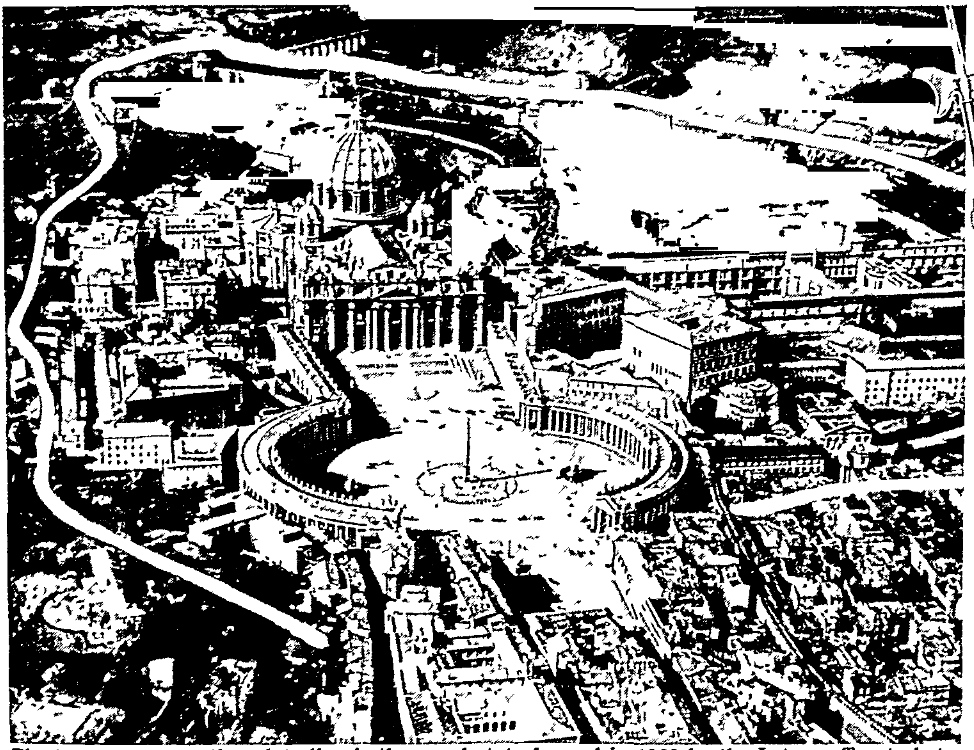
> Of all the bonny buds that blow
> In bright or cloudy weather,
> Of all the flowers that come and go
> The whole twelve months together,
> This little purple pansy brings
> Thoughts of the sweetest, saddest things.

This familiar garden favorite is a cultivated species belonging to the violet family. The story is that some 300 years ago someone carried specimens of the modest little wild flower from the woods to a cool moist place in his garden. There, in course of time, by selection and cross-fertilization, the flowers became larger and more brilliant, with rich coloring ranging from white and yellow into orange, dark brown, blue, violet, and purple; and so grew into the pansy of today. Now the plants may be bought and set out in beds in the garden; but the cheapest way is to buy the seed. Seeds are usually planted from mid-July to mid-August. During the winter the plants are kept in glass-covered boxes or under a mulch of leaves in the milder climates. These plants bloom in early spring By watering and plucking the pansies regularly, they may be kept blooming all summer.

Scientific name of pansy, *Viola tricolor*. Flowers have five unequal broad petals, five short stamens, five sepals eared at base; leaves long, sharp-pointed, sometimes oval, growing direct from stem; stem slender, one-half to one foot high, with single flower.

PAPACY. The "papacy" means the office of the pope of Rome and denotes the system by which he governs the Catholic church. The word "pope" is the English form of the Latin *papa* (derived from the Greek *papas*), meaning "father." The title pope was in early times given to all bishops; later it was restricted to the Bishop of Rome, the patriarchs of Alexandria, Antioch, Jerusalem, and Constantinople. At the present time it is employed by the Roman Catholics solely to denote the Bishop of Rome, who is regarded as the successor to St. Peter and the chief pastor of the Universal Church. It was apparently in the 4th century that the word pope was first used as the distinctive title of the Roman pontiff. The head of the Roman Catholic church has other titles, such as "Holy Father"; "Vicar of Christ"; "Pontifex Maximus" (literally, "chief bridge-builder," given presumably in imitation of the early Roman emperors, who exercised civil and religious functions); and *Servus Servorum Dei* ("the servant of the servants

VATICAN CITY, THE SMALLEST STATE IN THE WORLD



The territory within the white line is the papal state formed in 1929 by the Lateran Treaty between the Holy See and the Italian government. It is in the northwest corner of Rome, and St. Peter's church, with its imposing dome, dominates the scene. In front of the church is an impressive plaza, framed by Bernini's Colonnade, and ornamented by an Egyptian obelisk. The Vatican is the square building with the L-shaped wing in the right center of the picture, and, behind it, long wings house the museum and library. Running behind Bernini's Colonnade to the lower right-hand corner of the picture, is the covered passage from the Vatican to the castle of San Angelo (not visible) on the north bank of the Tiber. At the right is one of the picturesque Swiss papal guards.

of God"), which is now so exclusively a papal title that it is found in all official documents such as bulls and briefs.

According to Roman Catholic teaching, Christ in founding the church as a visible institution gave to St. Peter primacy over the other apostles, and made St. Peter his representative on earth by investing him with the three prerogatives of king, priest, and teacher, and bestowed upon him the highest legislative, priestly, and doctrinal authority. The primacy had been *promised* to St. Peter before the Resurrection, and was conferred when Christ manifested himself to St. Peter and the other apostles on the banks of the Sea of Tiberias. (This teaching is based upon what are termed the Petrine texts, found in Matthew xvi, 17–19; Luke xxii, 32; John xxi, 15–17.)

As the church was to endure till the end of time, Peter must have a successor, who, as Bishop of Rome, should be the Vicar of Christ on earth. History bears complete testimony that from the earliest times the Bishop of Rome has ever claimed the supreme headship of the Roman Catholic church, and that this headship has been universally acknowledged by all within the fold. The pope becomes chief pastor of the church because he is Bishop of Rome; he is not Bishop of Rome because he is chosen head of the church. As head of the church, the pope acts successively as Bishop of Rome, Archbishop of the Roman Province, Primate of Italy, and Patriarch of the Western Church.

In virtue of his position as head of the Roman Catholic church, the pope is its supreme teacher, legislator, judge, and governor. As supreme teacher he formulates what is to be believed by the members of the church, and takes measures for the preservation and the propagation of the faith. He alone can prescribe and regulate its liturgical services. As the supreme legislator of the church he makes laws for all its members, and has full authority to interpret, alter, or abrogate his own legislation or that of his predecessors. As supreme judge the pope can impose penalties either by judicial sentence or by general laws. As supreme governor he has the right of appointment to public ecclesiastical offices, such as the nomination of bishops, the establishment of dioceses, the approval of religious orders, and the authority to impose taxes on the clergy and laity for ecclesiastical purposes.

Though the pope's authority is supreme, it must not be understood that it is either arbitrary or unrestricted. He is directed in the exercise of it by the spirit and practice of the church; by ancient statutes and immemorial customs; by the very purpose of the papacy as expressed by Christ at the time of its institution: "Feed my lambs. . . . feed my sheep" (John xxi, 15–17). The pope is aided in his administration by a number of commissions, tribunals, and offices, collectively known as the *Curia Romana*. The commissions, known as "Roman Congregations," are 13 in number, each dealing with some special

branch of work; the Congregation of the Propagation of the Faith, for instance, having supervision of missionary activities; the Congregation of the Bishops and Regulars regulating the affairs of religious orders—monks, friars, and nuns. There are two tribunals, one for matters of private conscience and the other for cases between individuals. Appeal from the decisions of the latter may be made to the Apostolic Signatura or supreme tribunal.

Among the offices are the Papal Chancery, which sends out those formal documents issued under the pope's seal called "bulls" (from Latin *bulla*, a leaden seal); the Apostolic Chamber, which has charge of finances; and the office of the Secretary of State. This official is perhaps the best known of all representatives of the Vatican, as the papacy is often called from the place of the pope's residence. All the political affairs of the church and its dealings with foreign nations are conducted through him. From his office also are issued those less formal public letters known as papal "briefs." The members of the Congregations as well as other chief administrative officers are almost always cardinals (*see* Cardinals, College of).

The pope has primacy of honor as well as primacy of jurisdiction over all bishops of the church. He ranks first among Catholic princes; he is independent of every temporal ruler; and in Catholic countries his ambassadors have precedence over other members of the diplomatic body.

For more than 11 centuries without interruption the pope was a temporal as well as a spiritual sovereign, ruling a district that stretched across central Italy from sea to sea. This territory was known as the Papal States, or the Patrimony of St. Peter. Temporal power was wrested from the papacy in 1870 when the present kingdom of Italy was formed. The popes steadfastly refused to accept this loss of temporal power and remained "prisoners" in the Vatican until 1929, when a treaty was signed recognizing the sovereign power of the Holy See over "the City of the Vatican." Even during this period, however, the popes continued to maintain diplomatic relations with most of the nations of Europe and America.

The papacy, with its history of nearly 2,000 years, is one of the most ancient of existing institutions. In the registers of the church we can trace the line of Roman pontiffs in an unbroken succession back through the centuries from the present *occupant* of the papal chair to St. Peter.

The method of electing a pope has changed through the ages. In the early days of Christianity the pope was elected by the clergy and the faithful of Rome. At the present time, the election is made by the College of Cardinals assembled in conclave. There are four possible methods of election. The usual form, however, is the "scrutiny," or secret ballot. To be elected, a candidate must receive a vote of two thirds plus one. (For a list of popes, *see* the entry **Pope** in the FACT-INDEX at the end of this volume.)

The Interesting STORY *of* PAPERMAKING

PAPER. Long ago the Chinese discovered that a thin, wet layer of tiny interlocking fibers becomes paper when it dries. The new material gave them a cheap and handy writing surface, and its use spread rapidly. The Arabs learned how to make paper from the Chinese, and they brought their knowledge to Europe. When men learned how to print from movable type, paper became even more valuable.

For many years paper was used mainly for printed works, for writing letters, and for keeping records. Millions of tons are still so used each year. Even more millions of tons are made into thousands of useful articles, including tissues, wrappers, bags, building board and papers, shotgun cartridges, and even airplane wings.

How the Chinese First Made Paper

The ancient Chinese pounded rags, barks of mulberry and other trees, old fish nets, and hemp into *fibrous pulps*, which were dumped into a water-filled vat. The tiny fibers hung suspended in the water. To form a sheet of paper, a workman dipped a mold made of thin strips of bamboo into the vat. Holding it level, he lifted it out bearing a thin layer of fibers. The water drained between the bamboo strips as the workman gently shook the mold. The shaking caused the fibers to interlock (*mat* or *felt*). The matted fibers on the mold were then placed in the sun to dry into a sheet of paper.

Today many different materials are pulped, and paper is made of these on great machines. Yet, though almost all papers are made in wide, endless sheets, the basic processes are the same as those used by the ancient Chinese.

The Raw Materials for Paper

Early Europeans and Americans made paper of cotton and linen rags. Fine writing papers and some building papers still are made wholly or partly of rags. England makes much paper from esparto, a grass that grows in Spain and North Africa. Although some coarse papers are made of squeezed sugar cane stalks (bagasse), hemp, bamboo, jute, straw, and other vegetable fibers, the great bulk of today's paper is made of wood. About 90 per cent of all American paper is made of wood, and most of this from spruce, fir, hemlock, and pine. (*See also* Plant Life; Wood; Cellulose.)

Making Pulp from Wood

COMMERCIALLY practicable ways to make pulp of wood were discovered during the middle 1800's. In the first process fibers were obtained by forcing a log against a grindstone. This is called the *mechanical* or *groundwood* process. Wood also can be made into fibrous pulps by several chemical processes.

Grinding wood turns 90 per cent of a log into pulp. Groundwood pulp contains not only desirable cellulose fibers but other wood substances not wanted in the

better grades of paper. One of these is *lignin,* the agent that binds the fibers together. Chemical processes can dissolve most of the undesirable substances, and so finer papers are made of chemical pulps.

Chemical Pulping Processes

Wood for the chemical processes is cut into chips 5/8 to 1½ inches in size. Dumped into great *digester* tanks, they are cooked with steam in chemical solutions called *cooking liquors.* The periods of cooking vary, according to the kind of chemical and the degree of refinement needed, from 2 to more than 35 hours. A pulp is named for the process that makes it.

PULP LOGS

The man uses a measuring pole to estimate the number of cords of wood in the pile. Paper mills need many such piles of raw material.

Sulfite pulp has the widest variety of uses. The cooking liquor, *calcium bisulfite,* is acid, and so the digester tank must be lined with acidproof brick and mortar. Less than half of the wood becomes pulp. Sulfite pulps are made into several grades of book, writing, wrapping, and tissue papers. Most newsprint (on which newspapers are printed) is formed of a mixture of one quarter sulfite and three quarters groundwood pulps.

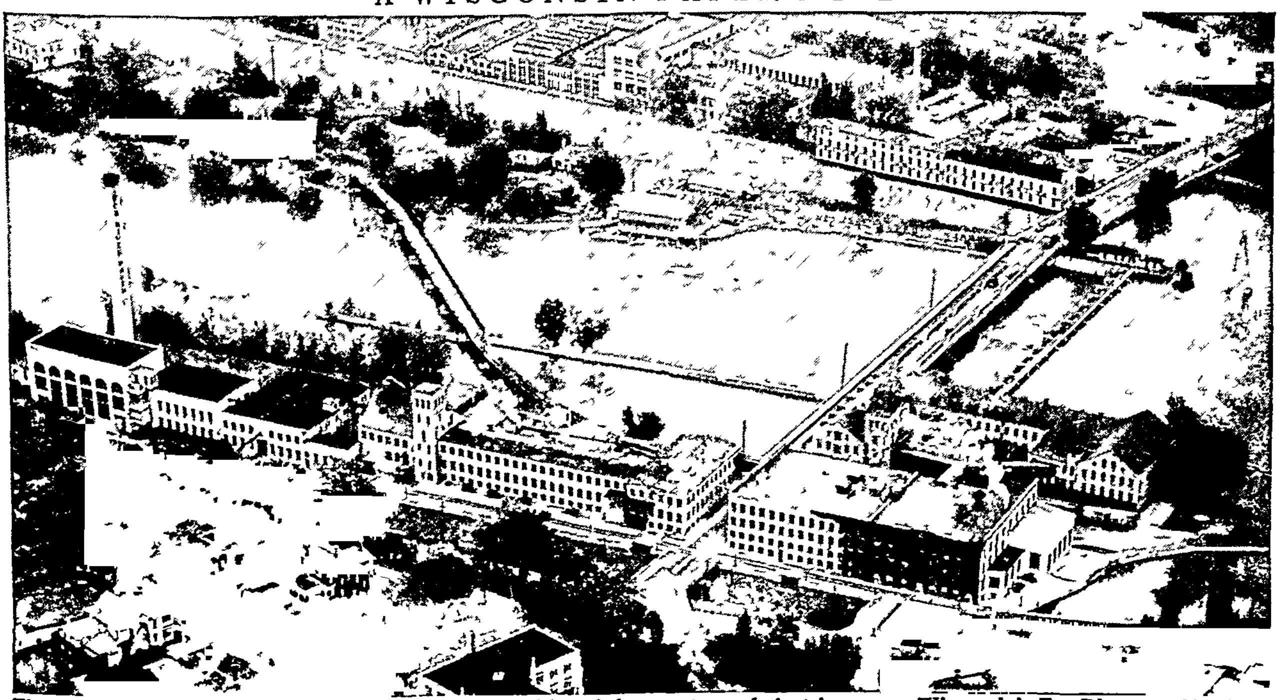
The cooking liquor of the alkaline *soda* process is *caustic soda.* The process is used mainly to pulp hardwoods, and the yield is 40 to 48 per cent of the wood. Bulky papers such as blotters are made of soda pulp. Mixed with sulfite pulp it is made into book, lithograph, and envelope papers.

Some pines, because they contain resins, waxes, and fats, resisted pulping until the alkaline *sulfate* process was discovered in 1884. Its cooking liquor is *sodium hydroxide* and *sodium sulfide.* The pulp yield is less than half the wood. Several kinds of paper are made of sulfate pulp, including kraft (from the Swedish word for strength), bag, boxboard, and —in higher grades—book, magazine, writing, and specialty papers.

The *neutral sulfite* cooking liquor is *sodium sulfite,* either entirely neutral or slightly alkaline. It is used to pulp both hardwoods and softwoods. The pulp is made into relatively high-grade printing papers.

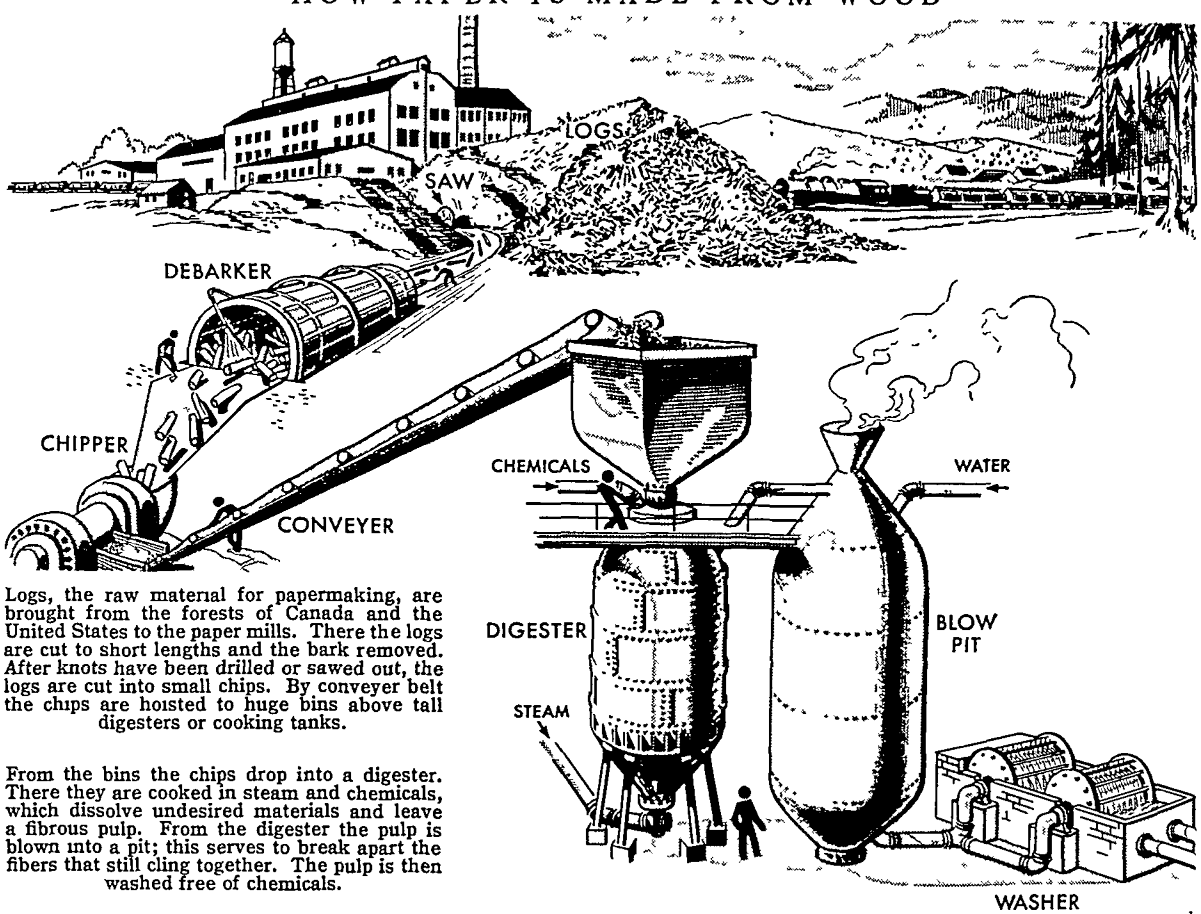
The cooking liquor for the *semichemical* process is either *steam* or *steam and chemicals.* The short cooking period softens the wood but dissolves only small amounts of undesired substances. An *attrition* machine mechanically pulps the softened wood. The yield is 70 to 80 per cent of the wood. Semichemical pulp is made into corrugated board (from hardwoods), lower-

A WISCONSIN PAPER MILL



The mills that make paper from wood need huge quantities of clean water and electric power. Wisconsin's Fox River provides both for the mill in the foreground. The dam, to the right of the bridge, holds back the river flow and channels it through a narrow passage. The swift current turns great turbines that change the water power to electric power.

HOW PAPER IS MADE FROM WOOD



Logs, the raw material for papermaking, are brought from the forests of Canada and the United States to the paper mills. There the logs are cut to short lengths and the bark removed. After knots have been drilled or sawed out, the logs are cut into small chips. By conveyer belt the chips are hoisted to huge bins above tall digesters or cooking tanks.

From the bins the chips drop into a digester. There they are cooked in steam and chemicals, which dissolve undesired materials and leave a fibrous pulp. From the digester the pulp is blown into a pit; this serves to break apart the fibers that still cling together. The pulp is then washed free of chemicals.

grade wrappings, roofing felts, and insulating boards. When bleached it is made into newsprint, glassine, and bond and book papers.

Further Pulping Operations

Additional refining steps include many washings, screening out bits of knots, sand, and other foreign matter, bleaching with chemicals, and beating (*see* Bleaching). All these steps require huge amounts of clean water, and so most pulp and paper mills are built on the banks of good-sized rivers or lakes.

The various pulps to be made into a single grade of paper are mixed in a *beater*. This usually is an open vat. The pulp flows around a partition down its middle. A great drum revolving on one side of the partition keeps the pulp moving. As the drum draws the pulp underneath, two sets of metal bars, one fastened to the drum surface and the other to the bedplate directly underneath, fray the tiny fibers so that when matted they will cling to one another.

The pulps mixed in the beater may be either in liquid form or in *laps* (thick, almost-dry sheets). *Sizing* and *loading* materials are also added in the beater. Sizing (animal gelatin, resins, alum, starch, or gypsum) gives strength to paper and makes the surfaces water repellent. Loading (China clay, pigments, and chalk) forms a surface coating and makes paper opaque. Dyes for colored papers, or blueing to further whiten pulp, also are added in the beater.

The final refining step is to pass the pulp through a *Jordan*, a cone-shaped machine with knives that cut the fibers to proper lengths. The pulp, now called *stuff* or *furnish*, is stored in tanks until needed in the *head boxes* of the papermaking machines.

Papermaking Machines

A CONSIDERABLE amount of paper is still made by hand. But in the United States and Canada all paper is made on machines. The most widely used machines are the *Fourdrinier* and the *cylinder*.

The Fourdrinier

The Fourdrinier is the larger and faster of the two machines. Much used sizes make *webs* (long sheets) of paper from five to twenty-five feet wide at a speed of 1,200 feet a minute. At the *wet end*, stuff flows from the head box onto a swift-moving endless mold called a wire. A side-to-side motion mats the fibers as water drains through holes in the brass plates that form the wire. At the point where the wire turns down and back, the web is picked up by an endless felt and carried through *press rolls* that squeeze more water from it. The web next travels over and under a series of large steam-heated *drying rolls*. At the *dry end* the web runs through a *calender stack*, which is several polished cast-iron rolls that "iron" the paper surfaces smooth. Beyond the calender stack the web is wound on a reel into large rolls.

Some enamel-coated papers are made on the Fourdrinier. The web, when partly dried, is coated with an enamel of China clay, chalk, white lead, or other pigments. It passes through the remaining drying rolls, the calender stack, and then is wound on the reel. When a roll has reached the proper size, it is detached, and the web is run through a *supercalendering* machine. This is a stack of polished cast-iron and fiber rolls. As the web passes between two of these the fiber roll indents a trifle, permitting the paper to slip a tiny bit. This slip further "irons" the surfaces.

The Cylinder Machine

A cylinder machine can make many kinds of paper, but it is particularly adapted to making paperboard, light papers, and tissues. Paperboards are made by laying one or more still-moist webs on top of another and pressing them into a unit.

In this machine the stuff is picked up by revolving cloth-covered cylinders partly immersed in a vat of stuff. The web passes onto an endless felt and is carried on to press and drying rolls. Several cylinders and vats can be operated together. Thin sheets and tissues are made from the web of a single cylinder.

Standard Paper Sizes

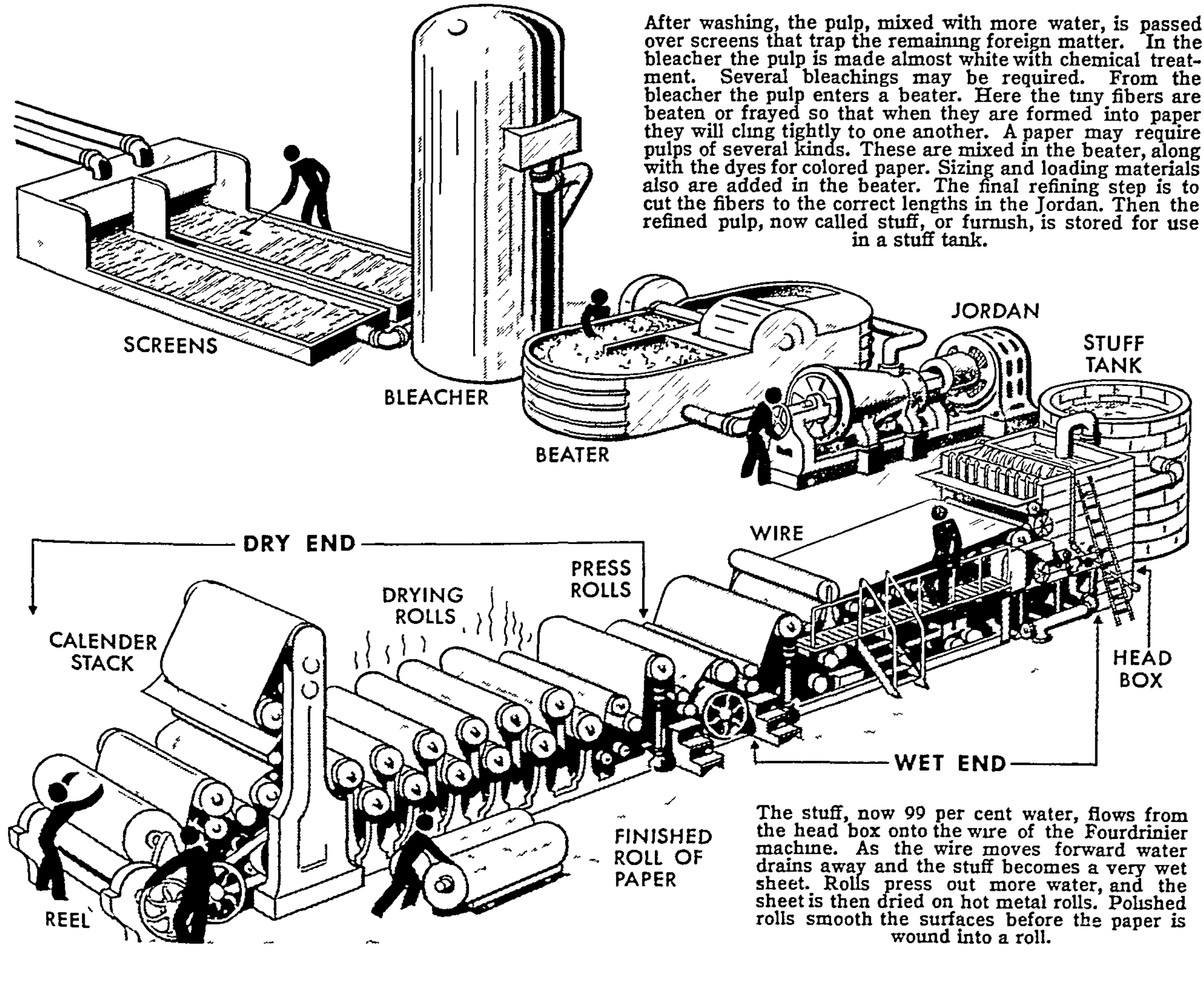
Printing and writing papers come in five main categories: *newsprint, writing, book, cover,* and *cardboard.* Weights, quality, and sizes vary widely within each category. In the United States sheets are sold in reams of 500. Weights are based on reams of standard-sized sheets. The most used sizes, given in inches, are: writing, 17 x 22; book, 25 x 38; cover, 20 x 26; cardboard, 22 x 28. Thus a ream of a 20-pound bond writing paper, usually sold in 8½ x 11 size, would weigh 20 pounds if the sheet size were 17 x 22.

Papermaking from Ancient to Modern Times

PAPER gets its name from the Egyptian papyrus plant, from which writing surfaces were made as early as 2300 B.C. Before the Chinese discovered how to make paper about A.D. 105, they used tablets of silk cloth and bamboo strips. Europeans used skins of calves, lambs, sheep, and goats—called vellum and parchment—to write on. (*See also* Papyrus; Books; Printing.)

Although the Chinese sold paper to the merchants who traveled the ancient trade routes, they long kept the secret of how to make it. By 600, however, the Japanese had learned the craft, and in the middle 700's captured Chinese papermakers were made to reveal their secrets to the Arabs at Samarkand.

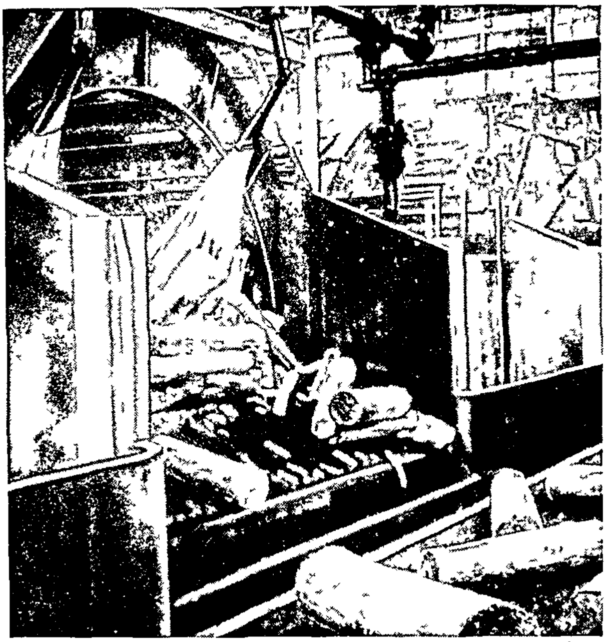
The Arabs introduced paper wherever their conquering armies traveled, across North Africa to Morocco



After washing, the pulp, mixed with more water, is passed over screens that trap the remaining foreign matter. In the bleacher the pulp is made almost white with chemical treatment. Several bleachings may be required. From the bleacher the pulp enters a beater. Here the tiny fibers are beaten or frayed so that when they are formed into paper they will cling tightly to one another. A paper may require pulps of several kinds. These are mixed in the beater, along with the dyes for colored paper. Sizing and loading materials also are added in the beater. The final refining step is to cut the fibers to the correct lengths in the Jordan. Then the refined pulp, now called stuff, or furnish, is stored for use in a stuff tank.

The stuff, now 99 per cent water, flows from the head box onto the wire of the Fourdrinier machine. As the wire moves forward water drains away and the stuff becomes a very wet sheet. Rolls press out more water, and the sheet is then dried on hot metal rolls. Polished rolls smooth the surfaces before the paper is wound into a roll.

DEBARKING THE LOGS



Bark is loosened and removed from logs by tumbling them in a huge drum under powerful streams of water. Moving belts then carry the logs to further processing operations.

and north across the Strait of Gibraltar to Spain. By 1150 paper was made in Spain and by 1250 in Italy.

Before 1200 the Europeans made use of water power to operate stone hammers for macerating rags. Other machines were invented, including the *Hollander* (in the 1680's), forerunner of the modern beater.

Many uses for paper continued to be found. Pasteboard was first made by Europeans in 1580; the Chinese and Persians had made it centuries before. The English found a way to make paper glossily smooth by coating it with white lead, plaster of Paris, and stone lime mixed with water.

Rags Become Scarce

The continually increasing demand for paper put a heavy drain on rag supplies. England ruled that the dead should be buried in woolen shrouds so that linen and cotton would be saved for the papermakers; yet rags grew scarcer. Other raw materials for making paper were suggested. Among these were wood (because a Frenchman had seen wasps building paperlike nests of wood), moss, marine plants, lichen, and asbestos (*see* Wasps; Asbestos).

A German pastor, Jacob Schaffer, turned his scientific mind to the problem of finding a substitute for rags in 1765. He made paper of more than 80 different vegetable fibers, including potatoes, wood, leaves, cornhusks, grain straws, and reeds. His papers were crude and of uncertain colors. Rags continued to be used.

Yet Europeans were now building horse-drawn coaches, sedan chairs, bookcases, and other articles of paper. In 1793 a paper church seating 800 was built in Norway; it was kept in use for 37 years.

The Invention of Papermaking Machines

In 1799 Nicholas-Louis Robert, a Frenchman, patented what was to become the Fourdrinier machine His invention had the all-important forward-moving, endless wire mold for matting stuff into paper.

Robert's machine was not a mechanical success. It was sold to two London stationers, the Fourdrinier brothers. They spent about $300,000 in their effort to perfect the machine, but a commercially successful machine was not developed until 1812. Although the machine came to be known as the Fourdrinier, the brothers never profited from their investment.

In 1809 John Dickinson, another Englishman, invented the cylinder machine. America's first cylinder machine was put into operation near Philadelphia in 1817; its first Fourdrinier began making paper at Saugerties, N. Y., in 1827.

How Wood Was Developed as a Raw Material

America's first paper mill had been started by William Rittenhouse, near Germantown, Pa., in 1690 By the time of the Revolutionary War every colony had a mill. During the war paper was so urgently needed that Massachusetts and some other colonies exempted papermakers from military service.

Straw had been made into paper for some time. But it was inferior; and so rags remained the principal raw material. Increasing demands for paper made it more and more difficult to find enough rags. Just before the Civil War one enterprising American temporarily solved the shortage by importing shiploads of Egyptian mummies so he could make paper of their linen wrappings.

TO STORAGE BINS

An endless belt carries wood chips to high storage bins. From the bins the chips will be fed by gravity to great cooking pots.

A German, Friedrich Keller, was the first to find a commercially practicable way to make wood into paper. In 1840 he obtained fibrous pulp from wood by grinding The pulp was weak and inferior, but when he added 40 per cent rag fibers the combination could be made into good newsprint.

Charles Fenerty, a Nova Scotian, discovered the same process in 1841, but it was not until 1867 that newsprint made of wood pulp was successfully used in the United States. Two of the chemical processes for pulping preceded this date—the soda process in 1851, and sulfite in 1857—but chemical pulping did not immediately come into wide use.

The Widening Use of Paper

Wood seemed to offer a limitless supply of raw material for

papermaking, but this was before it was discovered that paper could be made into as many as 14,000 or more useful articles. For some time the better papers continued to be made of rags, but as papermaking knowledge and skills grew, it was found that even fine paper could be made partly of wood pulp. Today, however, the very finest papers still are made of rags.

Before the 1900's strong wrappers and paper bags were developed. Cardboard boxes appeared. Harvard, Yale, and Columbia university boat crews propelled slim shells made of paper. Paper was molded into movable domes for some astronomical observatories, and for a time even railroad car wheels (except the rims and hubs) were made of paper—a paper product called papier-mâché (*see* Papier-Mâché).

The increasing demand for paper encouraged papermakers to build new mills close to raw material supplies—deep in the woods of Maine, New Hampshire, Michigan, Wisconsin, and Minnesota. Because paper made from wood could be sold more cheaply than paper made from rags, some of the old mills closed. Others survived because they turned their skills to making fine paper and papers for special uses, such as tissue and carbon papers.

The great forests of the North were ruthlessly cut to fill the ever-mounting demand for wood. Forest areas were cut over and left bare. Although there still were enormous supplies of wood in the forests of the Northwest, lumbermen and papermakers at the end of the 1800's began to worry about future supplies. Already mills needed to import logs from Canada. The more far-seeing mills bought thousands of square miles of the cutover land and on them planted new forests. Their foresters operated tree nurseries and offered advice and plantings to farmers, so that woodlots would become a source of supply. The foresters guarded the new forests from fire, disease, and blight.

A tree crop in the North needs 30 or more years to reach the sizes used in making paper. Some of the trees in the replanted forests are already being harvested, and for each tree taken out one or more saplings is planted. (*See also* Lumber; Forests; Conservation.)

In the meantime mill products were being converted into decorative crepe papers, napkins, sanitary tissues, cups, plates, napkins, tablecloths, and many other articles. Pieces of corrugated paper cushioned fragile objects when packed for shipping. Thick paperboard was shaped into cartons to replace the heavier and more costly wooden boxes. Builders used thick boards made of pulp for inner partitioning, insulating, and sound deadening.

The Spread of Papermaking

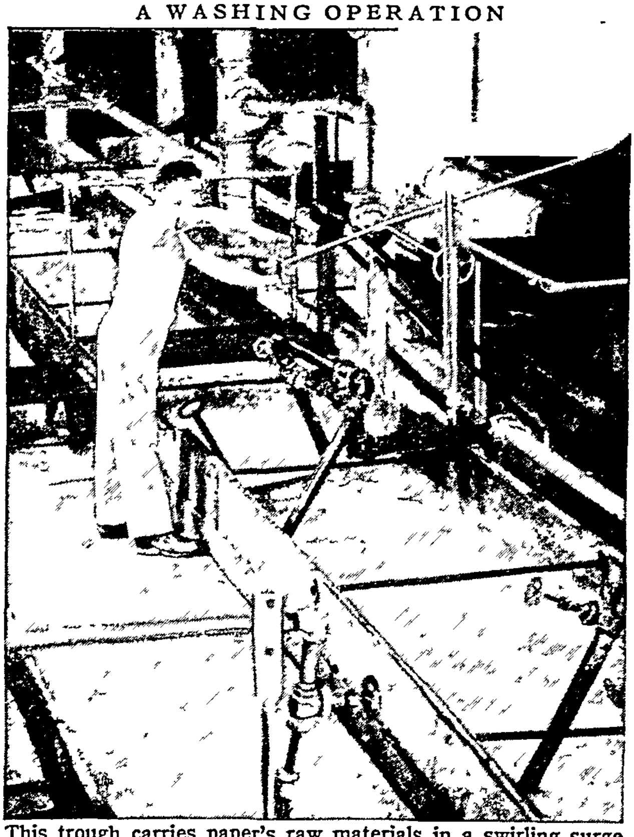
Paper mills swamped with orders began to turn toward the great Canadian forests. They established pulp and paper mills there. Today many American newspapers are printed on paper either made in Canada or made of pulpwood or of wood pulp shipped from Canada to American paper mills.

Just as some of the rag papermakers had turned to making fine papers and paper specialties, some American mills faced with wood shortages also turned to making fine papers and papers for new special purposes. Important among these new papers were waxed wrappers, better tissues and sanitary papers, and absorbent papers.

The South had thousands of square miles of fast-growing pines. Because the southern pines have a large resin content, it was thought that they could not be made into a pulp suitable for finer papers or even for newsprint. So the South first developed a paper industry that made only coarse kraft paper and fiberboards.

Dr. Charles H. Herty, an industrial chemist of Georgia, solved the problem of bleaching and refining southern-pine pulps, principally by proving that while old pines had a high resin content, young pines

A WASHING OPERATION

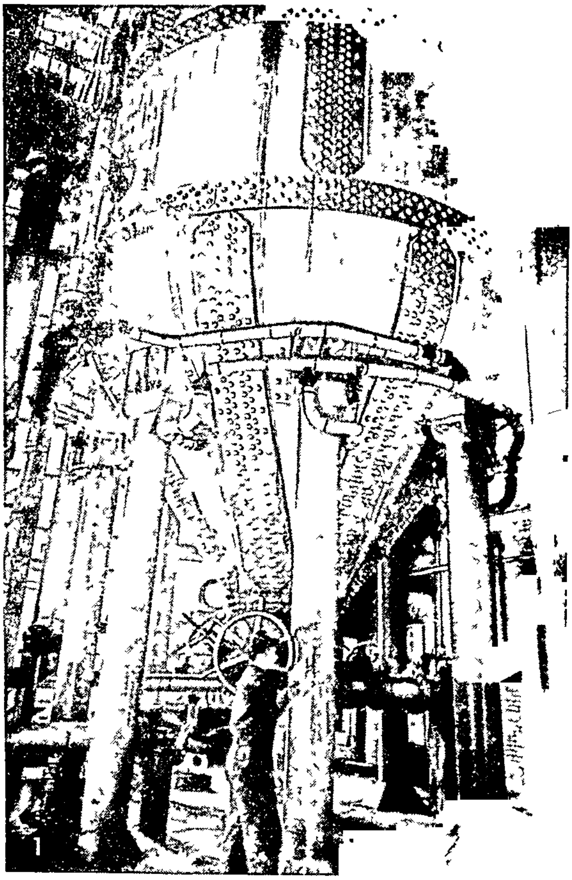


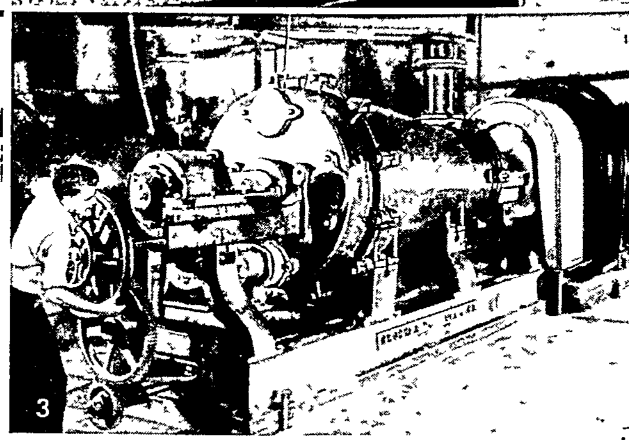
This trough carries paper's raw materials in a swirling surge over screens that trap and remove foreign matter. Good paper can be made only from clean pulp fibers.

did not. Many Southern newspapers are now printed entirely on Southern-made paper. The South's pines grow to pulping size in about 15 years, and so by following a wise reforesting program its papermaking industry is ensured an immense and continuous supply of raw material.

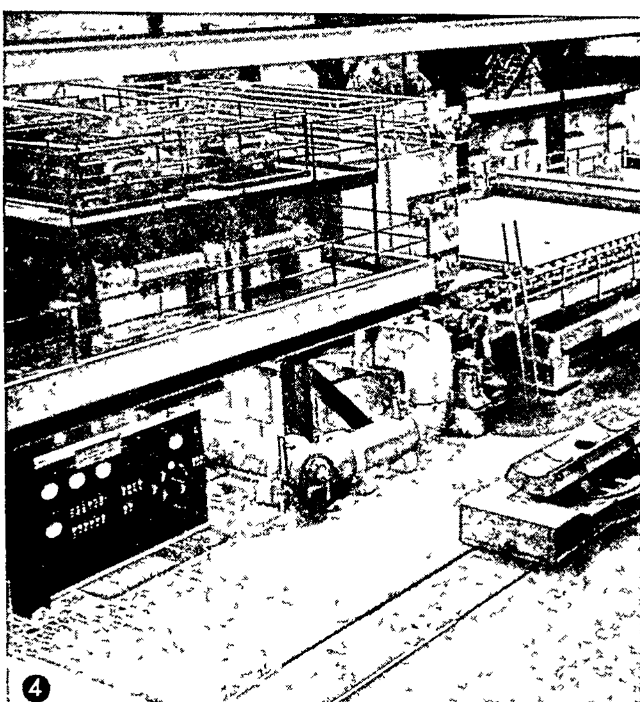
In the Northwest the lumbering interests also began to make paper. The more advanced of these interests are bringing a new economy to the industry. Logs and parts of logs unsuitable for sawing into lumber, formerly discarded as waste, are being con-

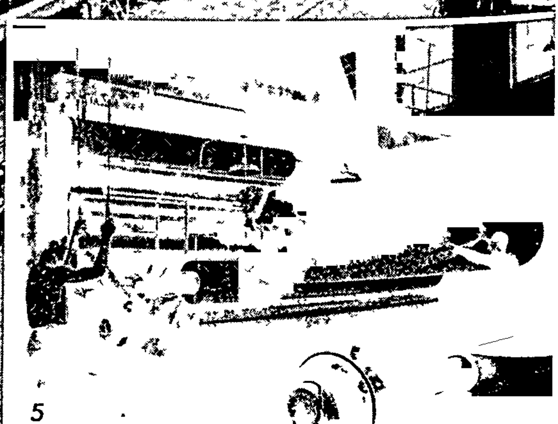
FROM WOOD CHIPS TO ROLLS OF PAPER





1. Wood chips are cooked with steam and chemicals in huge pots called digesters to dissolve and remove lignin, the material that cements wood fibers together. 2. In the beater the pulps required for a particular paper are mixed and refined. 3. The pulp next runs through a Jordan; its knives cut the fibers to proper lengths.





4. A Fourdrinier is a huge machine that can make a wide web of paper as fast as 1,200 feet a minute. Along its length, starting from the left, are pulp tanks, the mold or paper-forming wire, pressing rolls, hot drying rolls, calendering, or ironing, rolls, and the reel on which finished paper is rolled. 5. Workmen remove a roll of paper from the machine.

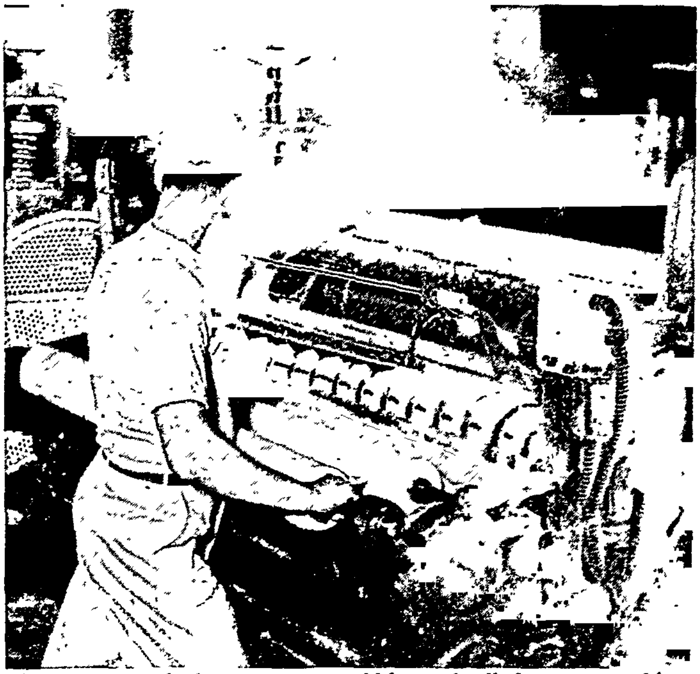
verted into paper. Researches carried on by the Institute of Paper Chemistry at Appleton, Wis., which is endowed by the papermaking industry, and by the United States Forest Products Laboratory at Madison, Wis., have found uses for other paper-mill wastes. These discoveries include vanillin, a substitute flavoring for vanilla, made of sulfite pulping wastes. Sulfite wastes also prove a good food for growing commercial yeasts (*see* Wood).

Although America imports much of its newsprint from Canada, it makes almost all its own finer papers and paper specialties. Specially long-fibered pulps are imported from Scandinavian countries. These are added to American pulps for making strong book and other papers.

The American Industry

Paper mills in the United States make over 25 million tons of paper and paperboard a year. In producing this, about 3¼ million tons of sulfite pulp, almost 8 million tons of sulfate pulp, and some 2 million tons of groundwood pulp are made from wood. Other fibrous materials used include about 8 million tons of wastepaper, almost 500,000 tons of rags, and more than 500,000 tons of straw. More than 400,000 production workers are employed in the American paper and paperboard industries. The products they make each year are valued at more than 3½ billion dollars.

A FINISHING OPERATION



Tissues are notched, cut to proper widths, and rolled on one machine. The upper cylinder carries the notching teeth. The knives are the disks seen above the finished rolls.

PAPIER-MÂCHÉ (*pä-pyā' mä-chā'*). Paper pulp, mixed with glue, paste, oil, resin, or other such materials, when dried under heavy pressure becomes papier-mâché. The words are French and mean "pulped paper." Many everyday objects are made of papier-mâché, including vases, trays, pails, doll heads and other toys, and architectural ornamental decorations (*see* Paper).

Papier-mâché was made in the Orient at a very early date, but it did not come into general use in Europe until the 1700's. There it was suggested as a material for building structures, ships and bridges, but it was not so used generally. It was first adapted to interior architectural decoration in England in the 1840's. In America during the last half of the 1800's revolving domes for astronomical observatories, university racing shells, and railroad-car wheels (except rims and hubs) were made of papier-mâché.

Another process for making papier-mâché uses heavy pressure to mold stacks of wet paper sheets that have been pasted together into a unit. Wastepapers and scrap papers are commonly used in this method. After molding, the papier-mâché article is dried by heat, hardened by dipping in a mixture of tar and linseed oil, and baked, trimmed, and painted. In painting the objects usually are covered with several coats of tar or lampblack, then they are varnished, lacquered, and polished.

PAPINEAU (*pa-pē-nō'*), LOUIS JOSEPH (1786–1871). From the year 1808, when he entered the assembly of Lower Canada (Quebec), until 1837, when he fathered a short-lived and unsuccessful revolt of French Canadian peasants against British rule, Louis Papineau was the stormy petrel of Lower Canada politics. His principal aim was a reform of the existing government (known as the "Château Clique"), which gave the British minority a monopoly of offices and power. In this effort he worked closely with William Lyon Mackenzie of Upper Canada (Ontario), who was leading a similar revolt (*see* Mackenzie).

As speaker of the assembly for nearly the whole of this period, Papineau was a continual thorn in the side of the council and of the British governors. One governor resigned (1827) rather than confirm Papineau's election to the speakership of the assembly. The trouble came to a head when the assembly for several years refused supplies to the governor and other officials. This was done in an effort to force the government to make the legislative council elective.

When this concession was denied the assembly, there was an outburst of resentment which culminated in 1837 in a series of uprisings by the "Sons of Liberty," as the revolutionists called themselves. The government troops made short work of the poorly armed and unorganized peasants and Papineau saved himself by fleeing to the United States. He remained there for two years, and later he went to France.

After the amnesty of 1849, Papineau returned to Canada. He was elected to a seat in the then united parliament. Again he agitated for the separation of Upper and Lower Canada, but the idol of the French Canadians had fallen. Papineau's influence was gone, and he soon retired to spend the remainder of his long life in seclusion.

PAPY'RUS PLANT. In ancient times the reed called papyrus (*Cyperus papyrus*) was widely cultivated in the Delta of Egypt. It was used for many purposes, especially for a kind of paper prepared from the stalk. The reed grows from three to ten feet high, with long sharp-keeled leaves, and soft naked stems as thick as a man's arm at their lower part; it is topped by numerous long drooping spikelets. The more slender stalks were woven into baskets, and the thicker ones, tied into bundles, were made into light boats. The fiber furnished material for cordage, sails, awnings, and matting. The pith served as caulking for boats. It was also used as food, being eaten raw or boiled. The root was dried and used for fuel and in the manufacture of utensils. The papyrus plant is now extinct in Lower Egypt, but still grows in the Upper Nile regions and in Ethiopia. (*See* Paper.)

THIS REED YIELDED THE FIRST PAPER

Here are papyrus reeds, the plant which gave the ancient Egyptians their paper. The tall, pithy stalks grow from ponds, and each has a crown of little flowers, carried on long spikes.

PAR'ACHUTE. Hold an open umbrella high above your head and try to pull it down quickly. You will find it difficult because the air offers so much resistance. This is the way a parachute acts. It uses the resistance of the air to ease the descent from an airplane or balloon. Parachutists have landed safely from heights of more than seven miles.

Parachutes are made with the utmost care. While cotton may be used, parachute fabric is generally nylon or light-weight silk specially woven with long fibers to give it strength and elasticity. The silk is left raw, that is, untreated, so that it will not crease. About 36 shrouds or lines of strong silk cord are evenly spaced around its circumference and connected to a harness that is strapped around the jumper's body.

The standard parachute is 24 feet in diameter, and packs into a bundle 18 inches square by 4 inches high, weighing 18 pounds. The packing must be done very carefully so that the lines will not become twisted. Attached to the top of the parachute is the little pilot 'chute, about three feet in diameter and equipped with ribs and springs of steel that force it open the instant it is released. The parachute pack is often so arranged that its wearer can sit on it, using it as a cushion. The pack itself is held together by two pins running through slots in its outer covering. Attached to each pin is a strong flexible steel cable, or rip cord, which is connected to the release ring on the jumper's left side. To open the parachute, the jumper pulls this ring, thereby drawing the pins out of the slots. The flaps of the bundle fly open and the little pilot 'chute pops out, opening instantly. This drags after it the big parachute, which opens almost immediately and checks the fall. A vent in its top allows some air to escape upward and thus tends to steady the course of the descent. This course can be altered by manipulating the shrouds. For example, if the jumper pulls down the shrouds on his left, air spills out from under the right side of the canopy, and the whole parachute slants off to the left.

Parachutes are used to enable fliers to escape from disabled airplanes, or to drop medical or other supplies to persons marooned on ice-blocked ships, in snowbound territory, or in otherwise inaccessible regions. Kits of fire-fighting tools are sometimes dropped to forest fire fighters by parachute. In wartime, the parachute is used as an important offensive weapon. "Parachute troops," and their ammunition and other supplies, are dropped at strategic points within the enemy's territory.

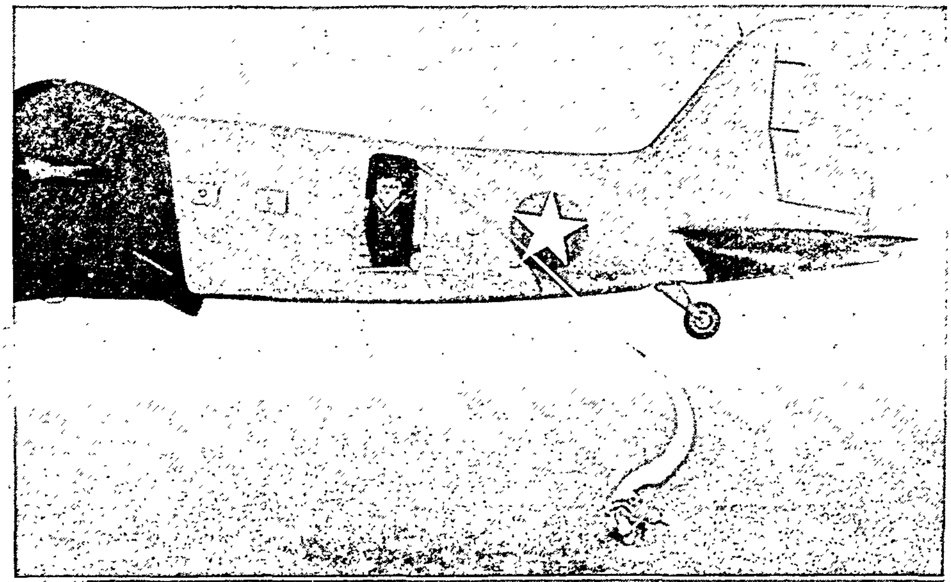
PARADISE BIRDS. The brilliance of the rainbow is mirrored in the plumage of the birds of paradise. The early Dutch explorers, the first Europeans to see these birds alive, believed them to be fed from the dews of heaven and the nectar of flowers. They thought that these tropical birds of Australasian regions lived entirely in the air. As proof, they displayed two cured skins of the birds, given them by the natives. From these skins the wings and feet had been so skillfully removed that the great naturalist Linnaeus himself did not detect the trick, for he named the principal species the *apoda*, that is, the "footless" birds. We know now that these birds are really related to the common crow.

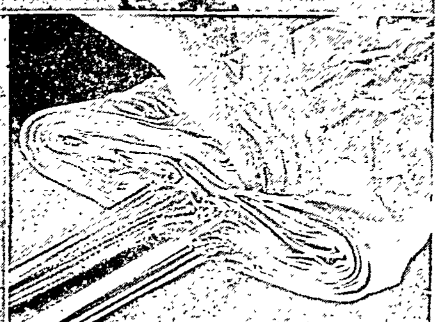
There are about 50 species of birds of paradise, all confined to the tropical islands of the western Pacific and northern Australia. The size of their bodies ranges from that of a crow to that of a sparrow, and each species has its own characteristic pattern of brilliant feathers.

The "great emerald" paradise bird is a changeable purple beneath, with head and neck of pale yellow, and forehead, cheeks, and throat of metallic green. Beneath his wings are tufts of delicate golden-orange feathers, which when the wings are raised fall over

JUMPING AND LANDING WITH PARACHUTES

At the right, a jumper plunges earthward after leaping from the plane's doorway. The long ripcord remains attached to the ship after it opens the parachute. In the picture below, we see a jumper, between heaven and earth, just about to pull the ripcord of his parachute. In the next picture to the right, a student jumper has landed. The wind tugs at his parachute and pulls him along. But the instructor shows him how to control it.





At the left, some parachute troops have landed, casting loose their parachutes, and are now hurrying to take their places in the line of battle. They carry their weapons with them. In the picture above, we see how a parachute is carefully refolded after use. A systematic procedure of refolding has been worked out and is followed exactly to insure that the parachute will open without fail.

Painting by Bruno Ertz

See text on opposite page

AMONG THE BIRDS OF PARADISE

The artist has included in his picture three species of the paradise birds, a lyre-bird, and, by way of contrast, a common black crow. Read more about this colorful assemblage on the facing page.

AMONG THE BIRDS OF PARADISE

KEY TO COLOR PLATE

MOST brilliant and showy of all birds are the many species usually grouped together as "Birds of Paradise." They live in the East Indian island of New Guinea, on near-by smaller islands, and at points on the adjacent north coast of Australia. Only the males have the fine plumage, which they show to gorgeous effect in "dancing parties," held in the mating season. Whether the plumage serves merely to win the favor of their mates, or thereafter serves a more lasting purpose in drawing natural enemies away from the nests and the plainly colored mother bird and young, is a point undecided by naturalists. The plumage, however, has nearly proved fatal to many species not widely distributed; for natives attend the "dancing parties" and shoot the males with blunt arrows so their valuable feathers will not be injured.

The Great Bird of Paradise (*Paradisea apoda*) is shown on the opposite page (1). His most striking feature is the great array of fine plumes springing from beneath the wings He is being viewed with admiration by his plainly colored lady (3). These birds are found particularly in the Aroe Islands, adjoining New Guinea. With them in the picture we see a King Bird of Paradise (2) and a Magnificent Bird of Paradise (4).

Curiously enough, the Crow down there in the corner (5) is a close relative of the Paradise family, far closer, indeed, than the Lyre-Bird (6), despite the fact that the latter would seem more suited to this gorgeous company. The Lyre-Bird dwells in Australia and like so many other animals of that continent is a primitive type, despite his elaborate trappings. Unlike the Birds of Paradise he is a capable singer.

him like the spray of a fountain. The "red" paradise bird has similar tufts of crimson and, in addition, curling tail feathers 21 inches long. The "superb" paradise bird has on his neck a feather-shield which he can spread about his head, in a fanlike circle.

During the mating season, the male birds congregate, as many as 20 in one tree, and show off their fine feathers before the females. Though they are usually wary, the birds are now so interested in their "style show" that hunters may shoot them at close range. After mating, the female lays two or three eggs in a nest in a tall tree, and takes entire care of the young when they have hatched.

Bird-of-paradise feathers used to be in demand for hat trimmings, but their importation into the United States has been forbidden. Other countries also discourage the slaughter of these handsome birds.

Scientific name of great emerald bird of paradise, *Paradisaea apoda;* of the red, *Paradisaea rubra;* of the superb, *Lophorhina superba.*

PARAFFIN (*păr'ă-fĭn*). This white wax seals jelly glasses, waterproofs matches, protects monuments and buildings, and serves many other purposes (*see* Wax). Cleopatra's Needle, the Egyptian obelisk in Central Park, New York City, has remained weatherproof ever since it was treated with melted paraffin in 1885. Paraffin is obtained by distilling petroleum, shale, coal, or wood. Most of the paraffin of commerce comes from petroleum (*see* Petroleum).

PARAGUAY (*păr'ą gwī*). Landlocked Paraguay has the smallest population of any South American republic (1,408,400—1950 census). It carries on the smallest foreign trade and is the least visited by foreigners. Vast stretches of its "wild west," the Chaco, alternately flooded and scorched by drought, have never been settled.

Its tragic history goes far to explain Paraguay's lag in progress. When it threw off the rule of Spain in 1811, it fell into the hands of a series of dictators who ruled it with a rod of iron until 1870. The first of these, José Gaspar Rodriguez Francia, exercised a personal despotism (1814–40) almost without parallel in modern times. He imprisoned, flogged, and executed his subjects at will. He made Paraguay virtually a closed country, and almost completely ended foreign trade. Francia's nephew, Carlos Antonio López (1844–62), opened the nation to the outside world and set on foot some wise reforms.

But the third of the despots, Francisco Solano López (1862–70), son of Carlos López, plunged his country into a war with Argentina, Brazil, and Uruguay that lasted five years. Paraguay lost two thirds of its people. The Chaco War with Bolivia in the 1930's was also costly in life and money. The nation has not recovered from these wars. Women outnumber men in the population.

The country is further handicapped by its isolation. It is the only South American nation except Bolivia that does not lie on the ocean. The capital, Asunción, is 950 miles north of Buenos Aires. To reach it travelers from Buenos Aires must take a train ride of more than two days or a steamer trip of four days, unless they travel by airplane.

The Land and Its Climate

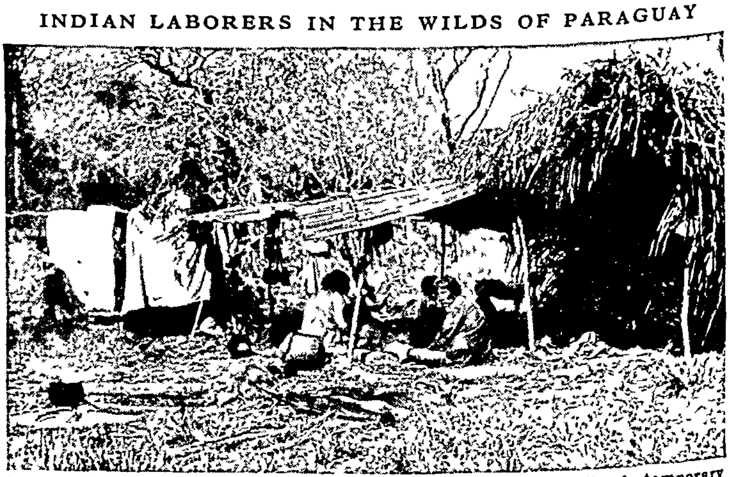
Paraguay is about the size of California, with an area estimated at 157,000 square miles. (For map, *see* Brazil.) One-third of it is in the tropics; its southern two-thirds is in the middle latitudes. The Paraguay River divides it into two distinct regions.

The eastern part, sometimes called Paraguay proper, lies between the Paraguay and Paraná rivers. Most of the people live in this area of about 62,000 square miles. This region is, for the most part, rolling and hilly. Through its center runs a broken line of highlands, nowhere more than 2,200 feet high. In the low, partly swampy, plain which slopes west toward the Paraguay are most of the farms and cattle-grazing lands. Nearly half of it is forest-covered with tropical hardwoods. The region that slopes east to the Paraná is a subtropical wilderness, mostly forested. Its wild yerba trees for centuries have been the source of the national drink, *yerba maté*, or Paraguay tea. These holly-like trees are also cultivated on large estates. The Guaira Falls of the Alto (Upper) Paraná are the country's most beautiful scenic attraction.

The remaining three-fifths of the country, west of the Paraguay, is part of the vast expanse of grassland and forest called the Chaco (*see* South America). Some Indian tribes live here, and a handful of immigrant colonists have started ranches and farms; but most of the Chaco is uninhabited and unexplored. Quebracho ("ax breaker") trees along the west bank of the Paraguay River furnish both a valuable tanning material and tough, durable wood used for railroad ties.

The climate is tropical or subtropical. In the summer (November to April) from about 30 to 40 inches

INDIAN LABORERS IN THE WILDS OF PARAGUAY



Indians employed in cutting quebracho logs in the Chaco region live in temporary huts as pictured here. The jug in the foreground is probably used for brewing *yerba maté*, or Paraguay tea, the favorite national drink.

of rain fall in Paraguay proper, and in the winter, from 20 to 30 inches. Dry winds from Brazil frequently bring droughts to the Chaco in winter. Cold winds from the south occasionally break the extreme summer heat.

The People and Their Cities and Farms

The people are chiefly of mixed blood. They are descendants of the Spanish settlers and Guarani Indian tribes. There are only a few pure-blooded Indians today, most of them living in the Chaco; and still fewer people of pure Spanish blood. Paraguay encourages immigrants but is too remote to attract them in numbers. Colonies of Mennonites from Canada and the United States have settled in the Chaco.

Guarani is spoken more widely than Spanish, the language of business and state. Schools are few in the rural areas, and at least two thirds of the people cannot even read and write. There is a university at Asunción. Roman Catholicism is the state religion. Health and sanitation have been improved in recent years, but tuberculosis, typhoid fever, and malaria take many lives, and hookworm saps strength.

Most of the people live on small farms or on large cattle ranches where cowboys, called *chacreros*, herd millions of cattle. Farm and village houses are usually of adobe with palm-thatched roofs. Among the chief crops are rice, coffee, beans, tobacco, manioc, oranges, and bananas. Cotton and sugar-cane growing are increasing. The manioc, or cassava, a starchy tuber, is the bread and potatoes of the people (*see* Tapioca). Their crude implements include the ax, hoe, and machete (a long, heavy knife). Since 1942, an agricultural commission from the United States has stimulated food production and raised health standards. Paraguay gradually assumed much of the cost of the program.

Asunción, the capital and only large city, is situated on a high bluff on the Paraguay River opposite the mouth of the Pilcomayo. Other cities are Villarrica, in the richest farm region; Encarnación, on the Paraná River; and Concepción, on the Paraguay.

The Paraná-Paraguay river system is a great highway of travel and trade. Vessels of 12-foot draft can reach Asunción. In addition to the main railroad to Buenos Aires, a few short lines run inland, making a total of 700 miles of railroad. Most roads are mere trails, but some 300 miles of paved roads were built with financial assistance from the United States.

Paraguay is largely self-supporting. Since 1941, the small foreign trade has been mostly with Great Britain, Argentina, and the United States. The chief exports are timber, cotton, quebracho extract, hides, beef extract, *yerba maté*, tobacco, and petitgrain oil (a perfume base distilled from bitter orange leaves). Except for textile weaving, manufactures are little developed, and foodstuffs, vehicles, and machinery are imported. Mining too has made no progress, although there are deposits of iron, manganese, copper, mercury, and other minerals.

Chief Historical Events

A Portuguese, Alejo García, crossed this region about 1524, and in 1526 Sebastian Cabot claimed the land for Spain. Spaniards seeking a route to the Bolivian silver mines founded Asunción in 1537. The Jesuits, who dominated the country from 1610 to 1767, introduced European plants and animals and taught the Indians better farming methods.

Independence was achieved in 1811, and a constitution, based on that of the United States, was adopted following the Paraguayan War (1865–70). Civil wars and periods of dictatorship, however, have characterized the modern history of Paraguay. In 1941 it broke with the Axis countries and strengthened its ties with Brazil. This neighbor granted Paraguay the use of Santos as a free port, and in 1943 canceled a war debt owed since 1872. (For Reference-Outline and Bibliography, *see* South America.)

PARASITES *of the* ANIMAL *and* PLANT WORLDS

PARASITES. The parasites of the plant and animal worlds live by attaching themselves to other plants and animals and feeding upon the bodies or food supplies of their hosts. The name parasite comes from a Greek word meaning "one who dines at another's table." It is applied to shiftless human beings as well as to parasitical plants and animals.

Great numbers of both plants and animals live partly or entirely by attaching themselves to other living things. All living animals, great or small, are liable to the attacks of the unwelcome visitors. Man is no exception. More than 150 distinct species of parasites may infest his blood, muscles, glands—in fact, almost every organ and tissue in his body. The most dangerous of human parasites are the disease-producing germs, which are responsible for such deadly ills as tuberculosis, malaria, diphtheria, scarlet fever, pneumonia, typhoid fever, and sleeping sickness (*see* Disease).

The number of parasites harbored by one host may be enormous. Several million have been found in a single horse. About 40 different kinds of parasites infest the dog; cattle and pigs have more. At least 20 kinds of parasites live on the frog. Even the thick hide of the rhinoceros does not protect him from the tick. Birds and quadrupeds, fishes and whales, even insects, are the unwilling hosts for myriads of smaller creatures. There is an old rhyme:

'Tis said that fleas have lesser fleas
Upon their backs to bite 'em,
And these in turn have lesser still,
And so ad infinitum.

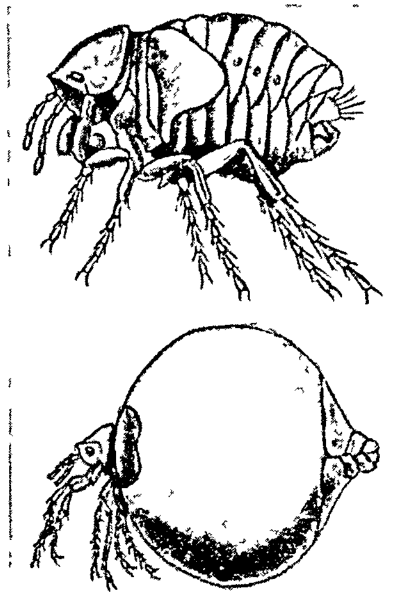
Even the tiny protozoa, the one-celled animals so small that we can see them only with the aid of a high-powered compound microscope, have smaller protozoa living on them.

We are all familiar with certain kinds of parasites. The famous "cooties," or body lice which infested

the soldiers in the trenches during the first World War, the mosquito, and the bedbug are examples. The chigger, or jigger, is a red mite (*Trombicula irritans*) common in the soil, grasses, and bushes of moist places. Its larvae attach themselves to human skin and feed until they are gorged and drop off. The irritating secretions emitted as they feed cause the itching which persists long after the larvae have disappeared. The parasite usually does nothing for its host in return for food, warmth, and protection. If present in great enough numbers, parasites will cause the death of the host.

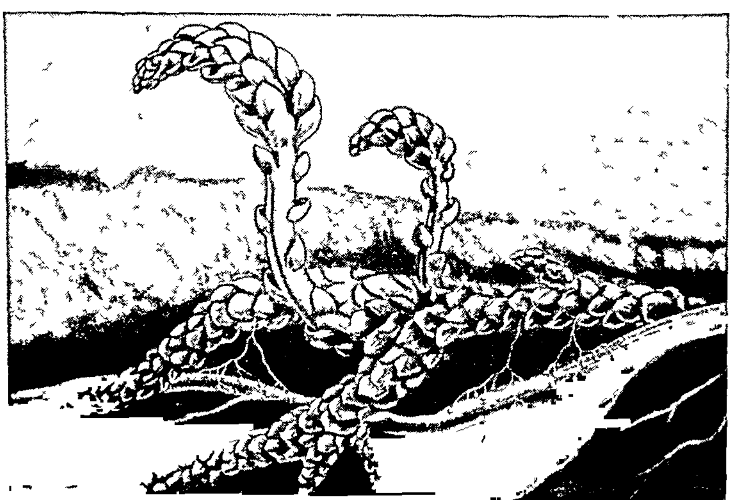
Parasites live on the outside of plant and animal bodies and often inside as well. Examples of external parasites are the lice, fleas, and ticks of animals and the plant lice and scale insects of plants.

THREE UNDESIRABLE GUESTS



This is a South American flea called a chigoe, or jigger as it appears before (top) and after (bottom) it has burrowed under the human skin. Jigger or chigger is also the name of a red mite common in the United States, whose larvae cause persistent itching.

The lamprey, one of the worst of parasites, clings to other fish with its cup-shaped mouth and rasps away their flesh.



The toothwort not only attaches itself to the roots of other plants but kills and digests small insects which venture to explore its leaves.

Some parasites live for their entire lifetime on the body of the host. Such parasites are called permanent parasites. The bird lice are permanent parasites. They lay their eggs on the feathers of the birds, and the young then descend to the skin when they hatch. Fleas are a different sort of pest. They often leap off the body of the host and may even go to some other host. Such parasites are called temporary parasites.

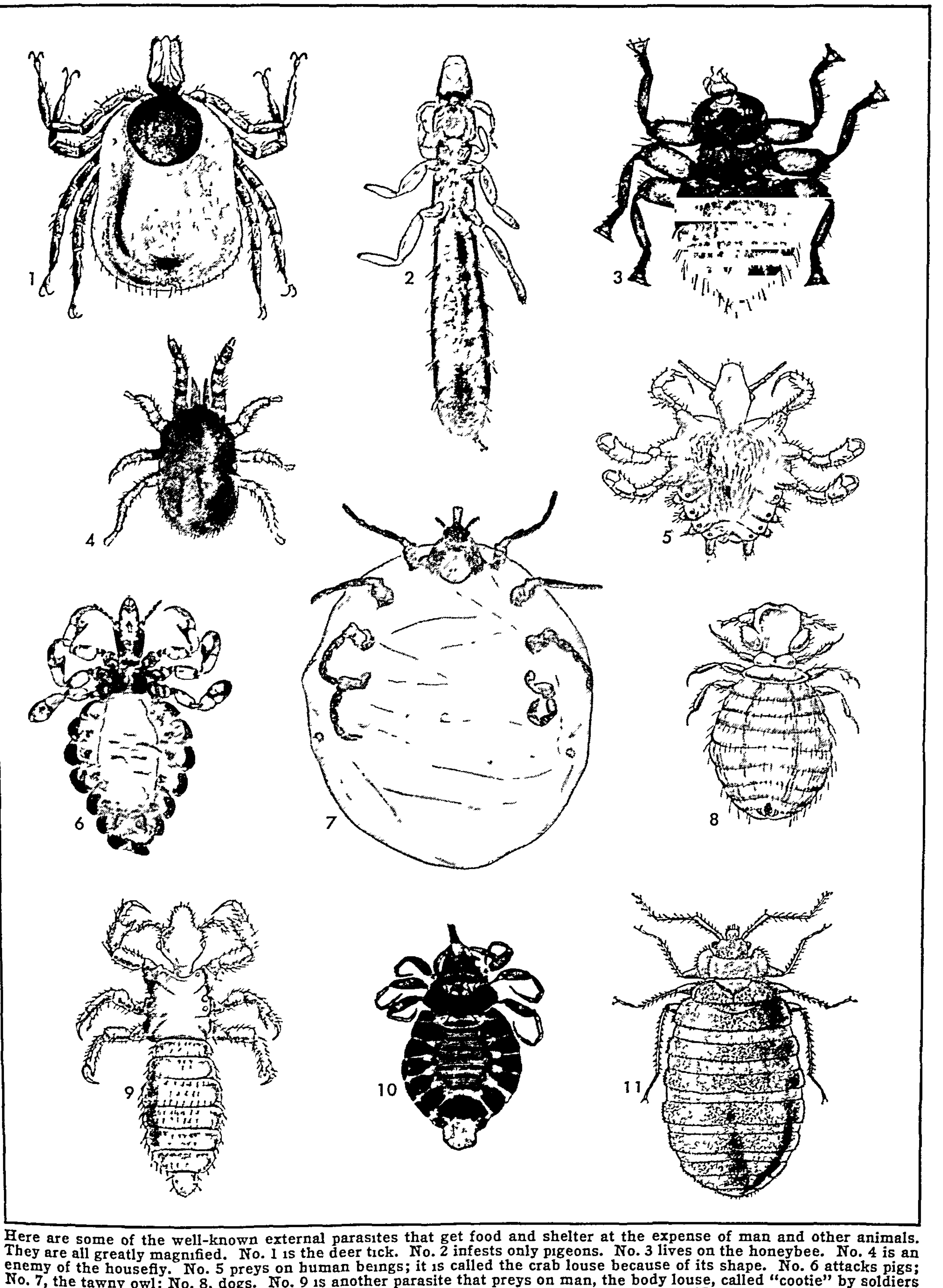
Some of the internal parasites most familiar to us are those that live within the human body. The most common of these is the tapeworm. It lives in the intestines and eats the food which is intended to nourish the body. When there are too many of these present they may cause the death of the host. The hookworm and the trichina are other internal parasites which live in man and cause serious disease (*see* Hookworm; Worm).

It often happens that the young of certain animal parasites are provided with a full outfit of legs, but soon they settle down and lose their legs. The legs are absorbed just like a pollywog's tail when it turns into a frog; and so during the rest of its useless life the parasite just sits attached to its host and eats and eats, and finally lays its eggs and dies.

The sacculina, which lives attached to certain kinds of crabs, is an example of this kind of parasite. Not only does this creature lose its legs, but also everything else that would make it look like an animal. Thus it becomes merely a bag for holding nourishment and a series of branches that penetrate the crab's body and suck its juices up. Such a loss of parts is called degeneration.

Most internal parasites are greatly degenerated You might say that they have shirked the struggle for existence, seeking a sheltered and easy life on the lowest possible terms; and so, according to the law of nature that an organ or function which is not used is lost, they have lost many powers which their ancestors once had. Many parasites which live firmly attached to their hosts have no legs or wings; and since they do not need to see their way about or watch out for food and enemies, they have also lost their eyes, ears, feelers, and other sense organs. Their food is predigested by their host, and so they have very simple alimentary

PARASITES THAT PREY ON ANIMALS AND MEN



Here are some of the well-known external parasites that get food and shelter at the expense of man and other animals. They are all greatly magnified. No. 1 is the deer tick. No. 2 infests only pigeons. No. 3 lives on the honeybee. No. 4 is an enemy of the housefly. No. 5 preys on human beings; it is called the crab louse because of its shape. No. 6 attacks pigs; No. 7, the tawny owl; No. 8, dogs. No. 9 is another parasite that preys on man, the body louse, called "cootie" by soldiers of the first World War. No. 10 penetrates even the armorlike hide of the elephant. No. 11 is the bedbug.

canals or none at all. Their organs of respiration and circulation, too, have degenerated, and so such parasites have become dull, inactive creatures at a low level of life.

Most animal parasites are invertebrates (without a backbone), though there are a few backboned parasites, such as the hagfishes or borers. These long eel-like fishes attach themselves to larger fishes and eat the muscles of their victims. Another fish parasite, the lamprey, rasps away the flesh.

Parasites in the Plant World

The best-known parasites on plants are the scale insects, which especially attack citrus fruits (*see* Scale Insects). Other parasites on plants lay their eggs in the plant tissues, and the young live and feed at the expense of the plant when they hatch out.

Some parasites are themselves plants. The dodder twines about other plants and sends little suckers into the host to get its food (*see* Plant Life). The mistletoe is a parasite on trees (*see* Mistletoe). Many of the fungi, particularly the shelf or bracket fungi that grow on trees, are parasites.

The damage done by parasites, both plant and animal, is enormous. Rusts, smuts, blights, mildews, and rots are dreaded foes of the farmer (*see* Rusts and Smuts). Not all parasites, however, are injurious to man's interests. That terrible pest, the tussock moth, is kept in check only by the 20 kinds of insects whose larvae live in the young moth and so destroy it. Many other injurious insects are kept down by their special parasites. Some of the worst insect pests in the United States are insects which have been brought from other lands without the parasites that keep them down in their native haunts. (*See also* Insects.)

The difference between "parasitism" and what is called "symbiosis" is the difference between "sponging" on a friend and going into partnership with him. The most interesting case of symbiosis is the lichen, which is a partnership between a fungus and an alga (*see* Lichens). The fungus supplies water and salts for the joint enterprise, and the alga manufactures the carbohydrates, on which both partners live. This odd sort of partnership also exists in other groups of plants, but it was first discovered in the lichens.

PARENT-TEACHER ASSOCIATIONS. For the most effective development of children there must be close coöperation between home and school. Parents must understand what the schools are trying to do, and teachers must understand the problems of parents. To bring about this understanding and coöperation is one of the chief aims of the many associations of parents and teachers which have been organized throughout the United States and other countries.

To promote the welfare of children these associations engage in many types of activities. They form groups to study education and child development. They improve school grounds and buildings, provide playgrounds, furnish libraries, support student loan funds, and give scholarships. Many of them also provide children with medical and dental care. In community work, they press such improvements as better housing, juvenile courts, and safety measures. They examine motion pictures, radio programs, and other forms of recreation, and work for their improvement.

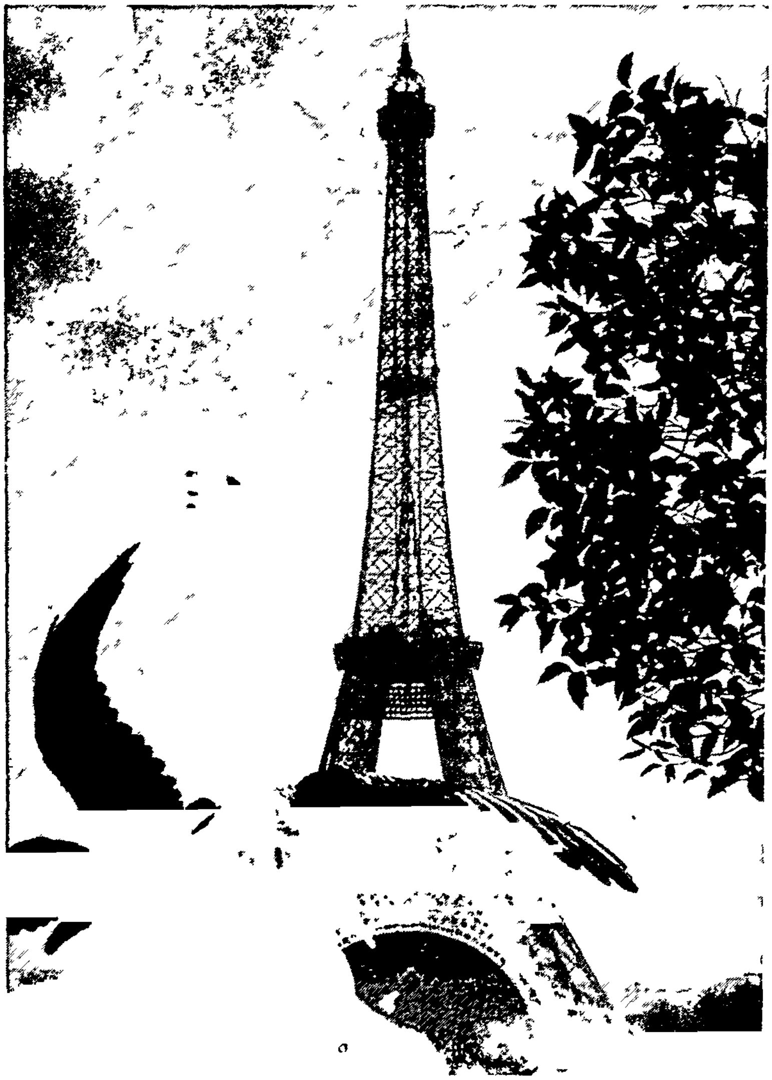
These associations grew out of the great interest in child development and education that arose late in the 19th century. Progress in child psychology revealed the educational significance of a child's early years. It was realized, as never before, that much of a person's success or failure in adult life depends on what he does in childhood. Some fathers and mothers came to a new conception of their duty to help children develop right habits of health, play, and work. They also saw that traditional procedures of training children, at home as well as in school, needed to be changed in the light of the new knowledge of child development. Some associations of parents and teachers, therefore, were formed, especially in California, Illinois, and Pennsylvania.

The National Congress of Parents and Teachers

This movement spread rapidly when it was sponsored by the National Congress of Mothers. The Congress, founded in 1897 in Washington by Alice McLellan Birney and Phoebe Apperson Hearst, promoted the organization of local groups. It soon broadened its scope to include fathers and teachers. In 1925 its name was changed to National Congress of Parents and Teachers. The local parent-teacher association is often called "the P.T.A."

Any person, even though not a parent or teacher, who is interested in the objectives of the National Congress may become a member of a parent-teacher association. Membership in a local group automatically carries with it membership in the state and national organizations. Each local group is a self-governing unit and plans its programs to meet the needs of its community. Some 37,000 P.T.A.'s, with more than 6,500,000 members in the United States, Alaska, Hawaii, and the Canal Zone, belong to the National Congress.

PARIS. Greek legend tells us that Paris was the son of King Priam of Troy, and that he brought about the Trojan War by carrying off beautiful Helen of Sparta (*see* Trojan War). Before his birth, his mother Hecuba dreamed that he was a flaming torch. This dream was taken to mean that the child would grow up to destroy the city, and so he was taken out to Mount Ida and left to die. But a shepherd saved him and he grew so strong and brave that fellow-shepherds called him "champion" and he won the love of Oenone (*ē-nōn'ē*), daughter of a river god. Their happiness was brief. Called upon to award the golden apple (as told in the article Trojan War), Paris gave it to Aphrodite, who had promised him the fairest woman in the world. Deserting his wife, Paris went to Troy, where he was recognized and acknowledged as the king's son. Then he sailed to Sparta and carried off Helen. In the war that followed, Paris treacherously slew Achilles, but was himself wounded in battle. He begged aid from Oenone. But she, bitter at his desertion, refused, and Paris died of his wound.



To people in every civilized country of the world, the Eiffel Tower is the one unmistakable symbol of Paris. Its lacy ironwork is seen at its best from the gardens of the Palace of Chaillot.

PARIS—*The* CITY *of* LIGHT

PARIS, FRANCE. To people all over the world Paris is a symbol of culture, charm, and beauty. Americans visiting Paris, from Benjamin Franklin to the tourists of today, have carried back a real love for this capital city of France.

Paris has an atmosphere unlike that of any other city in the world. It is a city of great beauty. Little industrial smoke hangs over Paris, for there are no big factories in the city. Without skyscrapers like those which shadow American cities, Paris lies open to the sky. The sun filters down through the many plane trees (called sycamores in the United States) which line its boulevards and avenues. Sunlight floods the spacious open squares, or *places*, and glitters on the placid surface of the Seine River, which curves through the heart of Paris. When the sun sets twilight is long, for this is a northern city, lying in the latitude of Gander, Newfoundland. Evening casts a soft light on the pale gray stone of the buildings.

When night comes, Paris is even more the City of Light, a name often given it. From the terrace of Sacré Coeur Church, on the height of Montmartre, the city below is a sea of twinkling lights. Viewed from an airplane at night, Paris presents its most impressive sight. Then the whole pattern of the city is set out in pinpoints of light. The viewer sees the curving boulevards as long thoroughfares enclosing the city in concentric circles. He sees the Place de l'Étoile with its floodlit Arc de Triomphe and the 12 wide avenues which radiate from it as a huge, spoked wheel. The Place de la Concorde looms up as a rectangle of light, the end of a long highway extending through the suburbs toward the channel coast. In all directions from the center of the city, roads reach out to every corner of France, for Paris is the true center of French national life.

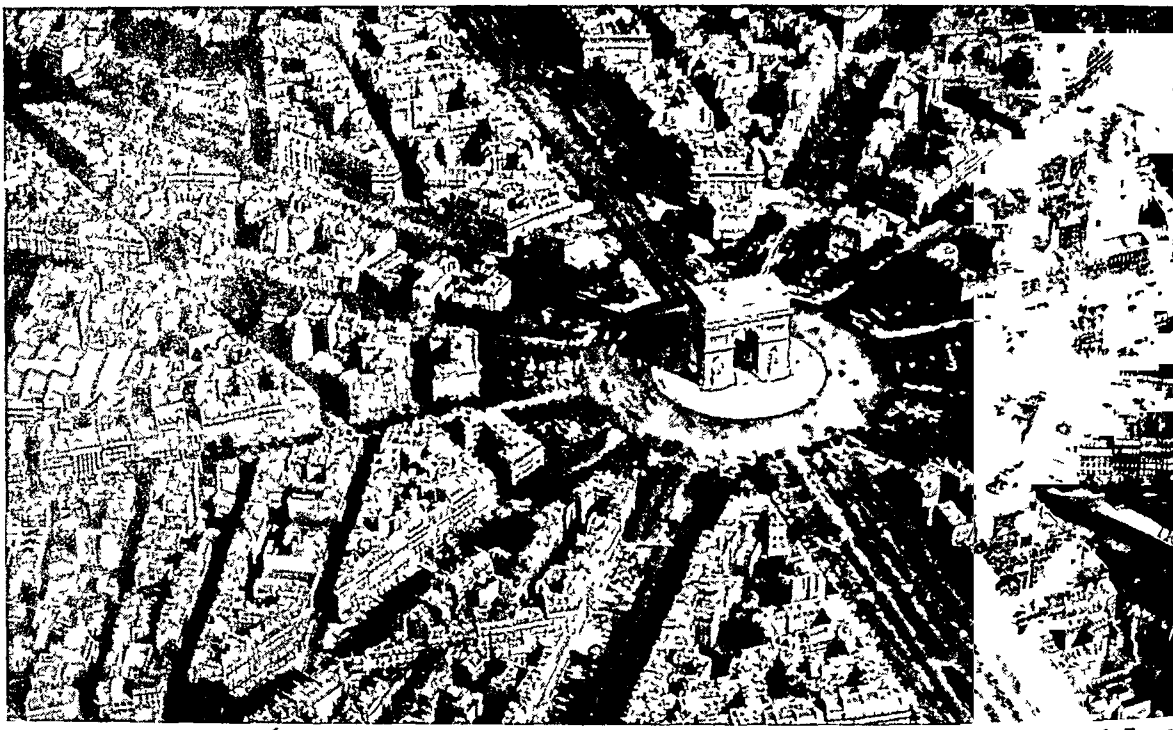
Its Location and Plan

The city of Paris is situated in the north central part of France. It is about 110 miles from the port of Le Havre on the English Channel. The city lies on both banks of the Seine River and is located near the center of the Paris basin. This shallow depression drained by the Seine is a rich farming region.

Within the city limits are two famous hills, the steep and rocky hill of Montmartre and the low rise of Mount St. Genevieve. Montmartre, crowned by the white Byzantine domes of Sacré Coeur, dominates the Right Bank, as the section of Paris north of the Seine is called. Mount St. Genevieve, named for the patron saint of Paris, is topped by the Panthéon. The high dome of this elaborate 18th-century building is a familiar landmark of the Left Bank. The Montparnasse district of the Left Bank once had its hill also, as the name implies. The hill disappeared long ago in the construction of the boulevards. From Montmartre and St. Genevieve low ranges of hills sweep round the city's center. Modern Paris spills over these to its limits on lower ground.

The plan of the city of Paris is striking and beautiful. Two main thoroughfares cross the city, meeting at right angles north of the Île de la Cité, an island in the Seine. The oval of the Grand Boulevards and the Boulevard St. Germain surround this crossing point and enclose most of old Paris. Outside this oval but still within the city limits are two other

THE ARC DE TRIOMPHE LOOKS DOWN THE CHAMPS-ÉLYSÉES



The magnificent Place de l'Étoile, "plaza of the star," is the meeting point of 12 wide avenues. With the huge Arc de Triomphe dominating the great circular open space, it is one of the most beautiful places in Paris.

complete rings of boulevards. These are the *boulevards extérieurs*, or outer boulevards, and the true outer boulevards, called the *boulevards militaires*, or military boulevards. Most of these boulevards were laid out on the sites of old city walls and fortifications. *Boulevard*, in fact, is a French military term for the flat top of a rampart.

Within the city are several famous parks. The favorites of Paris children are the Luxembourg Gardens and the Tuileries, where there are puppet shows and pools for sailing boats. Another park, the Jardin des Plantes, or botanical garden, has a world-famous zoo. Among the most beautiful small parks are the Parc Monceau and the high and rocky Parc des Buttes-Chaumont. Outside the military boulevards, but inside the city limits, are two huge parks, the Bois de Boulogne and the Bois de Vincennes. The Bois de Boulogne, often called simply "the Bois," has fine bridle paths, restaurants, lakes, and two race courses. It has long been a favorite park of the wealthy, while the equally beautiful Bois de Vincennes is preferred by the working people.

THE OPÉRA, CROSSROAD OF FRANCE

The vast, ornate Opéra reflects the taste of the Second Empire, the period in which it was built. The Place de l'Opéra, surrounded by fashionable shops and cafés, is the most important square of the Right Bank business district.

Population, Government, Climate

The city proper occupies about 41 square miles and has a population of 2,820,534 (1954 census). With more than 68,000 people to the square mile, Paris is one of the most densely populated cities in the world. Greater Paris, the city and its suburbs, extends over the entire 185 square miles of the Department of the Seine, an

administrative division equivalent to a state or province. This big urban area houses 5,154,834 people, one eighth of the entire population of France. (*See also* France.)

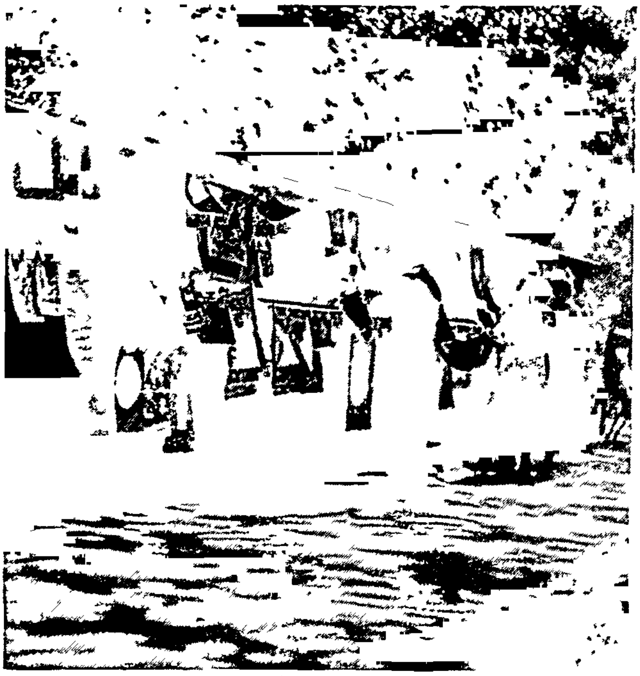
Paris is governed by an elected municipal council. The city is divided into 20 *arondissements*, or wards. Each of these has its own *mairie*, or town hall. Its mayor is appointed by the prefect, or governor, of the Department of the Seine. The *arondissements* all have names, but they are generally known by their numbers, which serve also as postal district numbers.

The climate of Paris is moderate and variable, as the city lies on the border between the seacoast region with its mild marine climate and the interior with its harsher continental climate. The light rains (about 21 inches a year) fall mostly as drizzle. The average midwinter temperature is about 36° F., and the midsummer temperature 66°.

Commerce, Transportation, and Communication

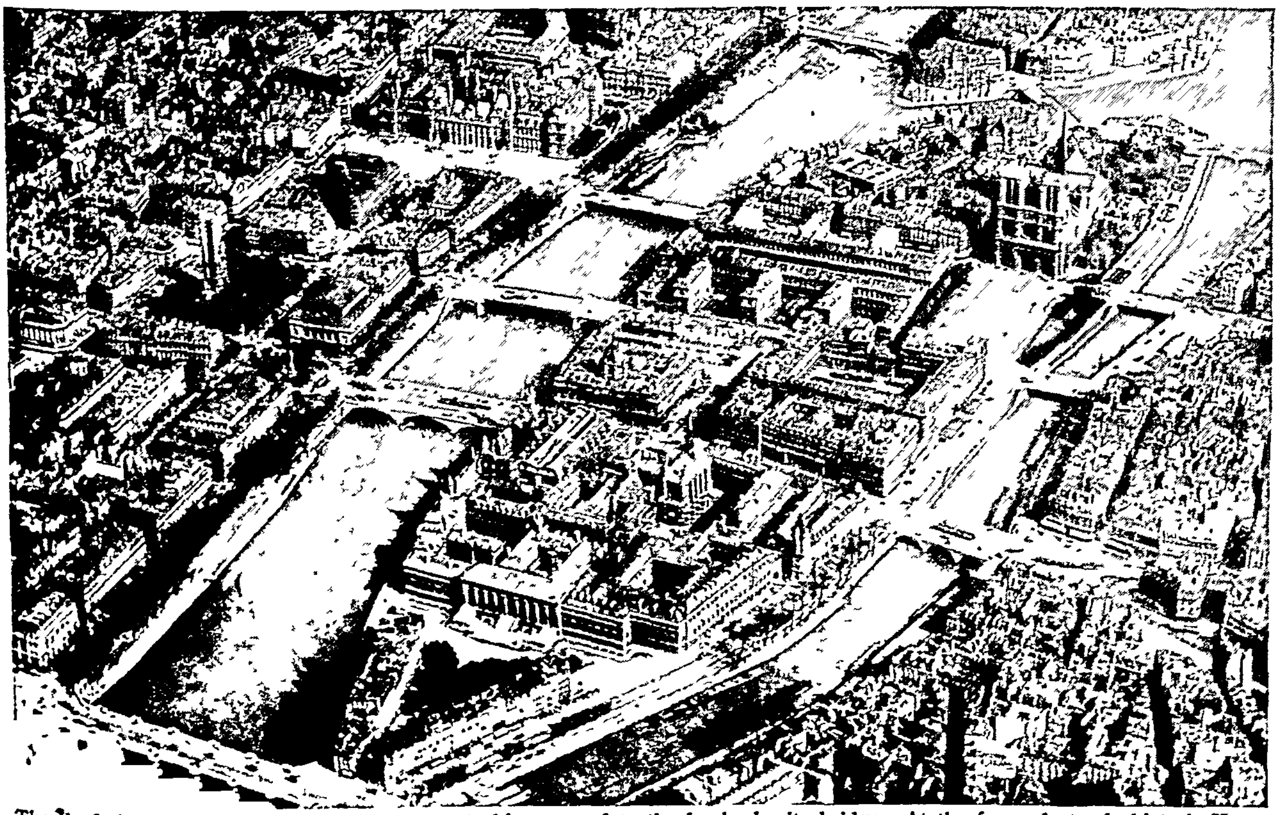
Paris is the commercial center of France and the hub of its transportation system. Here are the Bourse, or stock exchange, and the main offices of most of the leading business firms. Only light manufacturing is carried on in the outlying parts of the city. Heavy industry and automobile manufacturing are located in nearby towns. The most famous products of Paris are known as the *articles de Paris*. These are luxury goods such as perfumes, jewelry, cosmetics, and fine leather work. Paris has set standards in women's fashions since the Middle Ages. The famous *couturiers*, or custom dressmakers, have their shops in the Champs-Élysées district and in the area close to the Place Vendôme.

THERE MAY BE A BARGAIN HERE



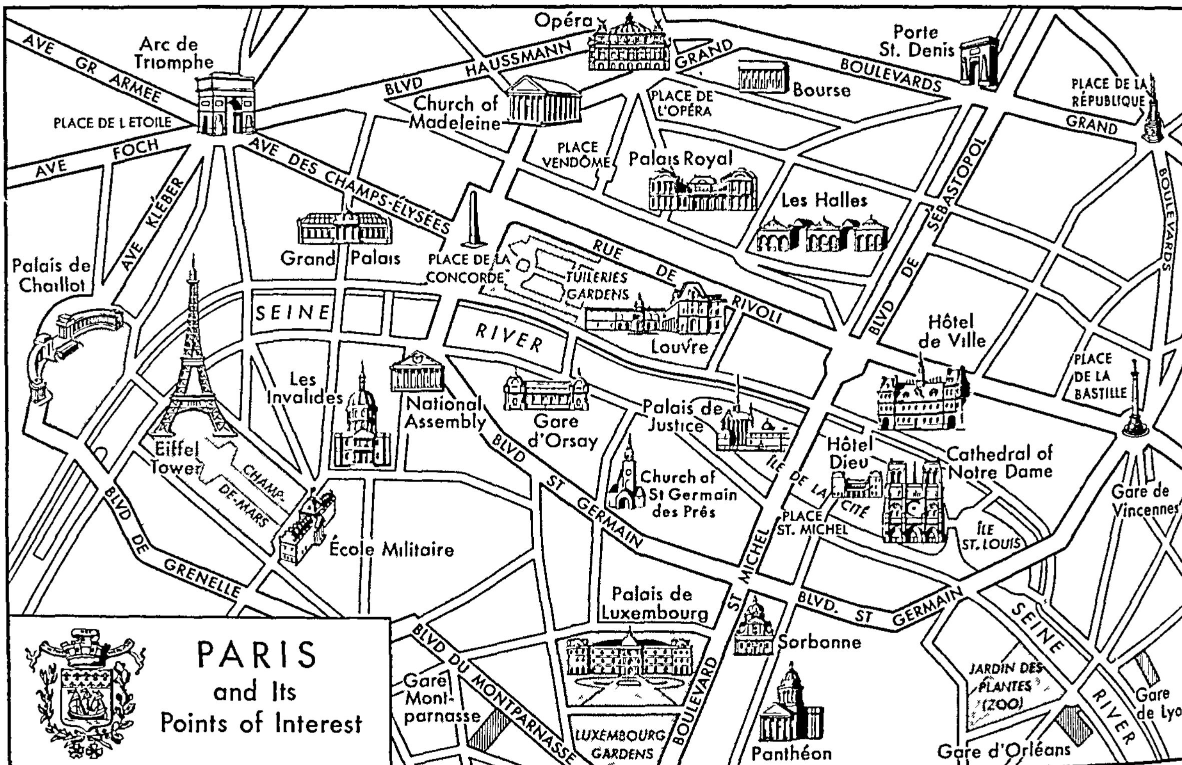
In the bookstalls along the Seine a stroller with plenty of time can still find a rare old book or a fine print for very little money. The green-painted stalls and their scholarly proprietors are among the most characteristic features of Paris.

THE ISLAND ON WHICH PARIS HAD ITS BEGINNING



The Île de la Cité from the air looks like a great ship, moored to the banks by its bridges. At the far end stands historic Notre Dame; at the other the lovely 17th-century Place Dauphine. Between lie government buildings and the little Sainte Chapelle.

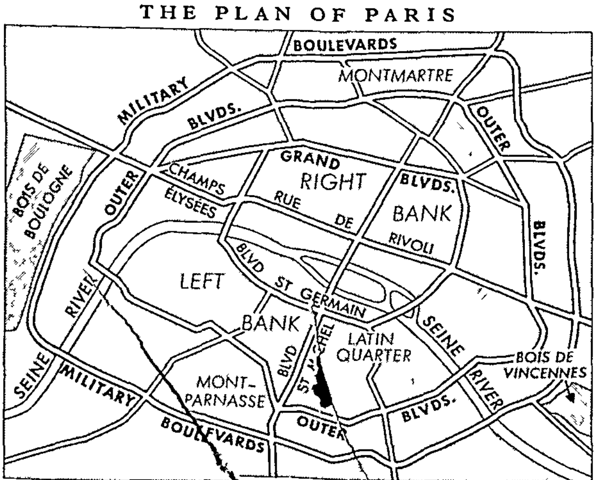
THE HEART OF PARIS, CAPITAL CITY OF FRANCE



This map shows many of the world-famous boulevards, streets, squares, and buildings of Paris. At the lower left are the historic arms of the city. The ship may represent the boat-shaped Île de la Cité or it may simply be a medieval merchant galley. The arms are surmounted by a Latin motto often translated, "Though buffeted by waves, she never sinks."

The transportation facilities of Paris are among the best in Europe. Eleven stations handle rail traffic to and from all parts of the Continent. The railroads are government-owned. Airlines connect Paris with most of the important cities of the world. Overseas traffic centers in Le Bourget airport, in a suburb northeast of the city. It is supplemented by Orly field, southeast of Paris. Orly was built during the second World War by American forces.

THE PLAN OF PARIS



The all-over plan of the city of Paris shows clearly in this small and simplified map. Notice how the center of the city is crossed by two main routes and encircled by concentric rings of boulevards. The two big parks are within the city limits.

Air passengers are driven by bus from the fields to the Invalides air terminal near the heart of the city.

Though far from the sea, Paris is an important port city. The Seine is navigable for barges and small ships above and below the city. A canal system stretching over most of France connects Paris with the Mediterranean and with the larger inland cities. The port of Paris handles a greater tonnage of freight than any other French port.

Within the city transportation is provided by busses and an excellent subway system. The subway (which Parisians call the "métro") was first opened in 1900. It played an important part in the second World War, when it was used by resistance forces.

Paris is the communications center of France. Its newspaper offices cluster near the Bourse. Some of the Paris dailies, such as *Le Matin* and *Le Figaro*, are famous throughout the world. The offices of most book publishers are located on the Boulevard St. Germain. The system of the Post, Telegraph, and Telephone (called the "P.T.T."), which is run by a government bureau, fans out from Paris. A unique system enables Parisians to send brief letters to any part of Paris and have them delivered within about an hour. A letter is written on a small blue form (a *petit bleu*), sealed, and sent through a network of pneumatic tubes connecting all post offices.

Perspectives of Paris

Paris, like Washington, D. C., is a city of "magnificent distances." Some of the most impressive

views are to be seen in the two-mile stretch of park and avenue joining the Louvre and the Place de l'Étoile. Standing in the Place de la Concorde near the center of this area, one looks eastward across the Tuileries Gardens to the Renaissance-style Louvre and westward up the tree-lined Champs-Élysées to the huge bulk of the Arc de Triomphe.

Still other beautiful views are provided by the park called the Champ-de-Mars ("field of Mars"). Here the old École Militaire (military college) faces the beautiful and modern Palace of Chaillot across the river. On the Champ-de-Mars stands the famous Eiffel Tower, built for the Paris Exposition of 1889.

A Tour of Paris

Paris grew from the Île de la Cité, and the visitor usually starts his tour of the city from here. Here is Notre Dame of Paris, the most important cathedral in France and one of the most beautiful. It was built between 1163 and 1330 (for pictures, *see* Architecture). Some of the most beautiful stained glass in the world is that of the Sainte Chapelle on the Cité. This tiny church is completely surrounded by the law courts, or Palais de Justice. Connected to the Cité by a foot bridge is the Île St. Louis. The fine old houses on its narrow streets probably give the best picture of what Paris was like in the 17th century.

The Right Bank district between the Île St. Louis and the Place de la République is called the Marais, or "marsh," because it used to flood frequently before the quays were built. Once an aristocratic neighborhood, it is now a district of working people. On the western edge of the Marais is the Hôtel de Ville, or old city hall of Paris. Nearby stand the vast sheds of the produce markets, called the Halles. Here farmers bring their fresh fruits and vegetables in the early morning hours.

Along the river on the Right Bank stretches the Palace of the Louvre. It is now a museum, and its long galleries are filled with the greatest art treasures of France. Among these are Leonardo da Vinci's famous 'Mona Lisa,' and the Greek statues known as the 'Venus of Milo' and the 'Winged Victory'.

Northward lies the National Academy of Music, invariably called the "Opéra." Around the Place de l'Opéra and its connecting streets are fashionable shops and many open-air cafés. At these cafés a visitor may sit for hours, if he chooses, and watch the passing crowd. According to an old saying, if he waits long enough he will see every one in the world.

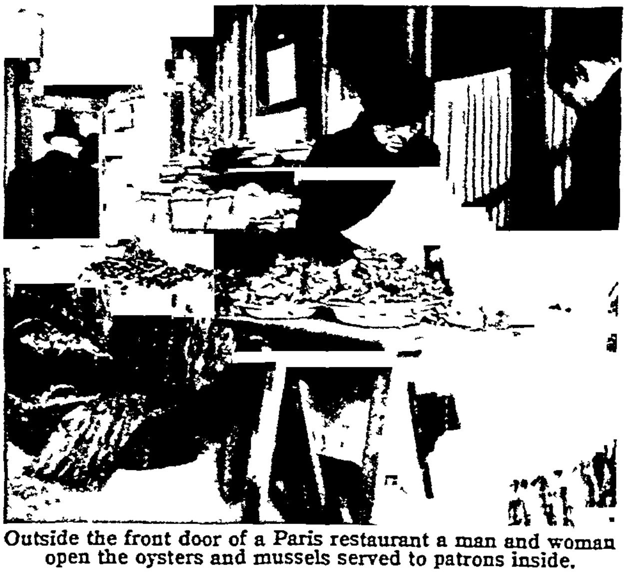
Close to the Opéra is the Madeleine. This rich and fashionable church is built in the form of a Greek temple. The pillared front of the National Assembly (formerly called the Chamber of Deputies) faces it from across the Seine and seems almost a reflection of the Madeleine.

In the Place de la Concorde stood the guillotine on which the king and queen of France were executed during the French Revolution. Near that spot now stands an Egyptian obelisk given to King Louis Philippe in 1831. The Arc de Triomphe faces the Concorde down the length of the Champs-Élysées.

SCENES OF PARIS LIFE

On a Sunday morning Paris children sail their boats in a pool overlooked by the Palace of Luxembourg.

The morning sun strikes flowers laid out in profusion at the flower market on the Île de la Cité.



Outside the front door of a Paris restaurant a man and woman open the oysters and mussels served to patrons inside.

Under the Arc is the tomb of France's Unknown Soldier. A flame, never allowed to die, burns above the tomb. Traditionally the armies of France and its allies have marched under the Arc and up the Champs-Élysées in their victory parades.

Among the interesting districts of the Right Bank are the former suburbs which are now part of Paris. Far to the north is Montmartre. Long outside the city limits, Montmartre still retains a village appearance. It has steep twisting streets and picturesque houses. Auteuil and Passy, between the Bois de Boulogne and the Seine, are fine residential districts with many beautiful houses and spacious grounds.

On the Left Bank, residential neighborhoods lie round the Champ-de-Mars and the Eiffel Tower. Eastward is the Invalides, an institution founded by Louis XIV for his disabled veterans. It now houses military offices and an army museum. Napoleon's tomb lies under the great dome of the building called the Dôme des Invalides. East of the Invalides is the St. Germain district, crowded round the church of St. Germain des Prés, the oldest church in Paris. Since the second World War this picturesque district has been the favorite of artists and writers.

The oldest part of the Left Bank is the Latin Quarter in which stands the Sorbonne, a part of the University of Paris. This district has been called the Latin Quarter since the Middle Ages because for centuries only Latin was spoken there. Many other educational institutions cluster near the Sorbonne. Nearby are the Cluny museum, with a rich collection of medieval art, and the Panthéon, where many of France's greatest men are buried.

The Long History of Paris

Paris has existed for more than 2,000 years. The first record of the city is in Julius Caesar's history of the Gallic wars. He called it Lutetia, the chief city of the Parisii, and described its position on the Île de la Cité. Under Roman protection the settlement spread to the Left Bank and up the slope of Mount St. Genevieve. The remains of Roman baths and a large theater have been excavated on the Left Bank. In time the name of the inhabitants eclipsed the Roman name of the city and it became known as Paris. Lutetia (in French, *Lutèce*) remains today only a poetic name for Paris.

Clovis, the great Christian king of the Franks, established his court at Paris in A.D. 508. With only brief interruptions Paris has remained the capital city of France ever since. Through the Middle Ages, Paris grew in size and importance. When the power of the French kings diminished, as it did from time to time, the count of Paris and the wealthy merchants took over the defense of the city. During the reign of Philip Augustus, 1180–1223, Paris prospered greatly. Philip built a wall around the city which remained its chief defense for two centuries. During his reign the University of Paris was organized and most of the cathedral of Notre Dame was completed.

In succeeding reigns the defenses were pushed outward as the city expanded. Pious King Louis IX, later canonized as Saint Louis, built the little Sainte Chapelle to house relics of Christ sent to him from Constantinople. In the 14th century, Paris took on the character of three cities. The Île de la Cité was the religious and governmental center. The Left Bank, dominated by the university, was the city of learned men; and the Right Bank, the city of merchants. Many public improvements were made in the 14th century. The ramparts of Charles V, which centuries later became the Grand Boulevards, were erected, and the first sewers were built.

Henry IV, first of the Bourbon kings of France, transformed the appearance of Paris during his reign, 1589–1610. He completed the classical Pont Neuf ("new bridge") which soon became a center of Parisian life. He rebuilt much of the Cité and the adjoining areas on either bank and set up a pumping system which supplied Paris with water for 200 years.

In the 17th and 18th centuries, Paris grew rapidly. Many old *faubourgs*, or suburbs, were taken into the city. With the French kings at the height of their power, the old ramparts became useless and so were transformed into tree-shaded promenades. Streets were widened and paved, and street lights appeared. The Champs-Élysées and many squares such as the Place de la Concorde were laid out. Two low islands in the Seine were joined as the Île St. Louis and soon were covered with the beautiful *hôtels*, or town houses, which still stand.

Building came to a standstill during the French Revolution (1789–95), but Napoleon I again took up the task of

THE PLACE DE LA CONCORDE

The Place de la Concorde is one of the largest and most impressive squares in the world. The Obelisk of Luxor in its center is flanked by two fountains in the Italian style. In the distance the façade of the Madeleine can be seen.

beautifying France's greatest city. He ordered the building of huge wine and produce markets needed by the growing city, and made a canal of the Ourcq River to aid commerce. He also began work on the huge Arc de Triomphe. It was completed in 1836 under Louis Philippe, who also carried out many other public improvements. The most notable was the Thiers wall, which stood until 1919 when it was razed to provide ground for the military boulevards.

Under Napoleon III, Paris assumed the general appearance it has today. Tremendous projects were undertaken and completed. Most of these were pushed through by the bold and vigorous Baron George Eugène Haussmann, prefect of the Department of the Seine. One of his greatest works was the building of the Paris sewers, made famous by Victor Hugo in 'Les Misérables'. He also constructed the Boulevard St. Michel and the Boulevard de Sébastopol, as well as many other wide streets. In approving such streets, Emperor Napoleon III was not concerned solely in making traffic move and in beautifying Paris. He wanted wide thoroughfares that could be raked by artillery fire in case of riots or revolution. Haussmann improved many of the parks of Paris and laid out the Bois de Boulogne. He also built many new bridges and innumerable public buildings such as the Opéra. More than any one man in the history of Paris, Baron Haussmann transformed the whole character and appearance of the city.

During the Franco-Prussian War Paris was under siege for more than four months. The city was shelled by the Germans but was not badly damaged. The inhabitants, however, nearly starved, for food supplies were cut off. In the period of unrest which followed the Second Empire, revolutionaries destroyed several public buildings. Notre Dame narrowly escaped being burned after its archbishop was killed.

The Third Republic (1875–1940) brought several world expositions to Paris, and these resulted in many public improvements. The Boulevard St. Germain was completed and the church of Sacré Coeur was built. Bridges, such as the ornate Alexander III Bridge, were built. The Eiffel Tower and the Paris subway were triumphs of French engineering skill.

Paris today remains essentially a 19th-century city. Most of its famous buildings, monuments, and streets date from that period of expansion. Paris was so magnificently laid out that the modern city can grow for many years on its 19th-century plan. The buildings of Paris suffered little during the two World Wars. When France faced defeat by Germany in the second World War, Paris was declared an "open city" to spare it from destruction. It fell to the Germans in 1940 and was occupied until liberated in August 1944. During those years Paris was the chief stronghold of the French resistance movement. Today one of the most familiar sights of Paris are the little plaques set up in the streets to commemorate persons who died there in the resistance.

A visitor to Paris should not leave without going beyond the low-lying hills which encircle it on all sides and visiting some of the interesting suburbs. St. Cloud is famous for its beautiful shady park and the view it commands of Paris. In St. Denis is the venerable abbey which is the burial place of many of the kings of France, especially of the Bourbon sovereigns, including the unfortunate Louis XVI and Marie Antoinette. Vincennes has an ancient castle that was long used as a state prison. Versailles is close to Paris, though not a suburb. Here is the famous Palace of Versailles with its lovely gardens and fountains. It is probably the most magnificent royal residence ever erected.

OLD AND PICTURESQUE MONTMARTRE

Montmartre, for centuries a village outside the walls of Paris, still keeps much of its old charm. This picturesque corner on the Place du Tertre is typical of Montmartre.

PARKER, SIR GILBERT (1862–1932). The lively, romantic stories of Gilbert Parker were among the first to deal with the life of frontier Canada. The novelist was born at Camden East, Ontario, Canada, and was educated at Trinity College, Toronto. In 1885 he went to Australia and became associate editor of a newspaper in Sydney. He later traveled among the Pacific islands and in Europe, Asia, and Egypt.

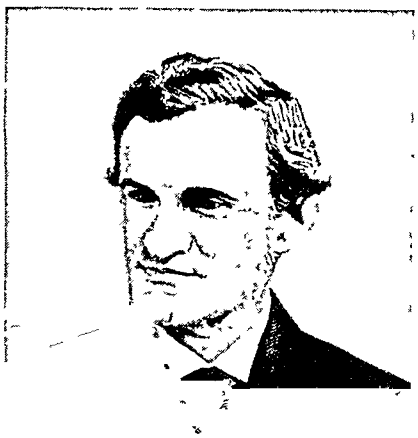
In 1889 he settled in London and turned to writing stories of Canada. After many discouraging failures he produced the vivid stories which he published as 'Pierre and His People' in 1892. The book was an immediate success. Parker's best novels, such as 'The Right of Way', 'The Seats of the Mighty', and 'The Trail of the Sword', deal with pioneer life in his native land. In other of his novels the scene is laid in Egypt, the South Sea islands, or other romantic lands. His stories never penetrate deeply into human character or the problems of life, but the characters are interesting and the plots are skillfully handled.

Parker took a very active interest in politics. He was elected to the British House of Commons in 1900 and served there for many years. In addition he

was a member of a number of important committees. During the first World War, he had charge of the British publicity work in America. In this capacity he wrote many magazine articles, some of which may prove of permanent literary value. He was knighted in 1902. In 1915 he was made a baronet for his war work.

Sir Gilbert Parker's chief works are: 'Pierre and His People' (1892); 'Mrs. Falchion' (1893); 'The Trail of the Sword' (1894); 'When Valmond Came to Pontiac' (1895); 'An Adventurer of the North' (1895); 'The Seats of the Mighty' (1896); 'The Pomp of the Lavillettes' (1897); 'The Battle of the Strong' (1898): 'The Lane that Had No Turning' (1900); 'The Right of Way' (1901); 'Donovan Pasha' (1902); 'History of Old Quebec' (1903); 'A Ladder of Swords' (1904); 'The Weavers' (1907); 'Northern Lights' (1909); 'Cumner's Son' (1910); 'The Land, the People, and the State' (1910); 'The Judgment House' (1913); 'You Never Know Your Luck' (1915); 'The World in the Crucible' (1915); 'The Money Master' (1915); 'The World for Sale' (1916); 'Wild Youth, and Another' (1919).

PARKMAN, FRANCIS (1823–1893). While he was still a sophomore at Harvard University, Francis Parkman, the most brilliant of American historians, resolved to write the story of the struggle between the French and English for the possession of the North American continent—or as he says—"the history of the American forest." He made his next few years a preparation for the hardships which he knew that he must undergo in collecting material among the Indians of the Northwest. Never robust, his health broke down one summer under the Spartan exercises which he practiced, and he went to Europe for a year of rest and travel. Notwithstanding this, he was graduated with his class in 1844, taking high rank.



FRANCIS PARKMAN
Brilliant American Historian

Already his vacations had been spent in exploring the woods within easy reach. In 1846 he started out with a friend for a trip over the then new Oregon trail. From St. Louis they traveled up the Missouri River to the site of Kansas City. There amid a rough crowd of all sorts and ranks of people they bought their horses, gathered their outfit, and hired their guides. After enduring many hardships they finally reached the valley of the Platte River.

They pressed on across the lonely country which stretched "for league after league as level as a lake," with "skulls and whitening bones of buffaloes scattered everywhere." They visited many Indians in their camps and were entertained by them according to their customs. In return, the two white men gave a feast at which the Indian delicacy, dog-meat, furnished the chief dish, and the very sweet tea was colored with soot, to make it seem stronger. Parkman had ample opportunity to study the Indians as they really were, and not as they had been sentimentalized by Cooper and other writers.

Parkman's trip was of inestimable value to him in carrying out his life's plan, but it undermined his delicate health. A diet exclusively of meat, exposure to storms, fatigue, and a lack of any care during a severe illness, made him an invalid for the rest of his life. The chief trouble was with his eyes. He could not bear light and was forced to spend most of his time in a darkened room. There were periods, too, when any thinking or writing made him feel as though there were an iron band around his head.

In spite of these difficulties, however, he published 'The Oregon Trail' on his return, and several years later appeared 'The Conspiracy of Pontiac'. Parts of these books he wrote with his own hand, guiding his pen in a darkened room by means of wires strung at intervals across a writing board. His wife and her sister as well as members of his own family helped him by reading aloud, gathering material, and taking his dictation. Sometimes he could write only six lines a day, and it took him two and one-half years to complete one of his books.

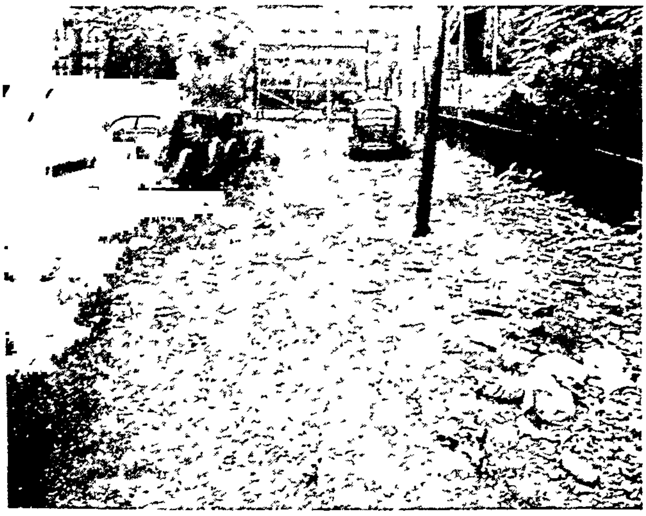
In 1858 Parkman's health was so bad that he had to give up work altogether. He went to Paris to consult the best physician of that time, but found no relief. No matter how much he suffered he always turned a cheerful face to the world. Few people knew what it cost him to give up writing and turn to raising roses.

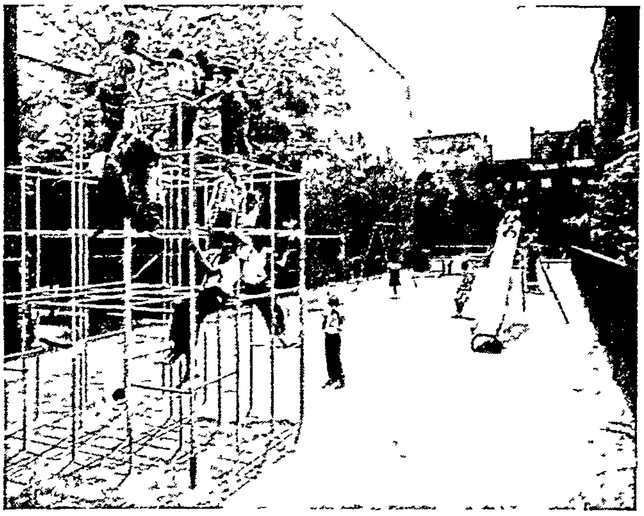
After seven years he had recovered his health sufficiently to continue his work, and in 1865 he began the publication of his long series of books dealing with the history of France in the New World. His books were recognized as of the highest order, and Parkman had the satisfaction of knowing that his work was appreciated at its full value.

His place as an historian is high, for he had a combination of unusual gifts. He had the tenacity and patience of a great scholar in collecting material from all possible sources. Not only did he gain a firm basis of fact, but he knew how to treat those facts with great literary skill. He made the lonely trapper, trader, soldier, priest, and voyageur live again his life of adventure amid the wilds of a new world, whose forests, streams, prairies, and mountains are so vividly described that they too like the kings, statesmen, and explorers became part of the historic drama. 'The Oregon Trail' should be read by everybody who is interested in the development and early history of the great West.

Among the best of Parkman's books are 'The Oregon Trail' (1849); 'The Conspiracy of Pontiac' (1851); 'Montcalm and Wolfe' (1884); 'A Half-Century of Conflict' (1892).

Modern CENTERS *of* COMMUNITY LIVING





Neighborhood play lots provide children in congested districts with a safe place to play. A trash-littered lot behind a billboard, used for parking automobiles (left), has been cleaned up, fenced in, and equipped with a "jungle gym," slides, bars, and swings (right). Here children can take part in healthful activity with no danger from street traffic and filthy alleys.

PARKS AND PLAYGROUNDS. Countless people of all ages find enjoyment and recreation in public-owned parks and playgrounds. Municipal parks bring country living to the city. Here are flowers, trees and shrubs, streams and lakes, and best of all, open space. Neighborhood playgrounds enable children who live in congested districts to play in safety.

The modern park is a center of neighborhood leisure-time living. Its services to the public have broadened to include active sports for young and old. In well-equipped field houses people may learn arts and crafts, hold club meetings, and enter into the civic and social affairs of the community.

Early Parks and Playgrounds

The origin of parks can be traced to the ancient hunting preserves of the Egyptians and Romans. Early European parks were formed around the castles and dwelling places of the royal families and the nobility. James Boswell's 'London Journal' spoke of St. James' Park in London where the footguards paraded and the ladies of the court strolled in the mall. The Luxembourg Gardens and the Tuileries Gardens of Paris, once royal parks, now belong to the people. In the Vienna Woods, on the outskirts of the Austrian capital, where the Hapsburg rulers hunted wild game, city dwellers today bicycle and picnic.

Boston Common, established in 1634, was the first city park in the United States. The New England commons were originally used to pasture the stock, to market foods, and to drill the militia. In 1853 Frederick Law Olmsted helped to acquire and design one of the first modern parks, Central Park in New York City. Essex County, New Jersey, established one of the earliest county park systems in 1895.

Playgrounds, like parks, grew out of the industrialization of cities. They were established to reduce accidents to children, to help fight off sickness caused by slums and crowded living conditions, and to keep young people out of trouble.

Joseph Lee of Boston and Jacob Riis of New York were pioneers in the playground movement. The first *legislative action to establish playgrounds* was taken by Brookline, Mass., in 1872. Boston opened a sand garden for children in 1885 and its Charlesbank Outdoor Gymnasium for men and boys four years later. Jane Addams' famous settlement, Hull House, in Chicago, started a model playground in 1892. Los Angeles appointed the first Board of Playground Commissioners in 1904. The national playground movement received its greatest help when the Playground Association of America (now the National Recreation Association) was organized in 1906.

Legally, a park is a plot of land permanently dedicated for ornamental and recreational purposes. It cannot be disposed of or used for any other purpose except through court or legislative action.

Municipal and county parks and playgrounds of the United States are financed through tax levies, appropriations, bond issues, and other public funds (90 per cent). Additional funds for operating the facilities are made available through fees for such activities as golfing, boating, horseback riding, picnicking, and dancing (6 per cent). A limited amount of money is supplied through private sources (4 per cent).

Parks and playgrounds are administered by boards and commissions whose members are either elected or appointed by the mayor to serve without pay. Trained workers are employed to perform the actual work of developing and operating the facilities. State parks are managed and maintained by park departments in the state government. The national parks and monuments are operated by the National Park Service in the United States Department of the Interior (*see* National Parks and National Monuments).

Different Kinds of Parks

Many different kinds of parks serve a variety of needs. The neighborhood park is a landscaped area of rather formal design. Its purpose is to make the neigh-

borhood attractive and to provide opportunity for quiet and informal recreation. Usually it is a few acres in size, but it may be as small as a corner lot. In some communities these small plots are known as "baby parks" because mothers wheel their infants and little children there for their daily outing.

The recreation park is much larger in area. It has woodlands, lawns, hills, meadows, lakes, and streams. There are gardens, arboretums, and conservatories, bird sanctuaries and zoos. Facilities are provided for picnicking, hiking, horseback riding, boating, swimming, and outdoor active sports of all kinds. In such parks are usually located the city's art institute, natural history and science museums, its aquarium, planetarium, band shell for outdoor concerts, and outdoor theater.

SAND-LOT BASEBALL

Park playground directors teach a group of boys the proper way to bat and catch a ball. Baseball and softball lots are among the most popular park facilities Adults and children use them, and games are held between neighborhood teams

Forest preserves or reservations are on the outskirts of cities. They are often a part of county, regional, or metropolitan park systems. Their primary purpose is to keep the woodlands and water areas in their primitive condition and to save them from destruction by growing industry and ever-expanding housing developments. They have no uniformity of design or limit in size.

The parkway, or scenic boulevard, is a long, narrow strip of land, planted with ornamental trees and shrubs, paralleling a road restricted to pleasure traffic. Roadside parks are found along major highways. Picnic tables, fireplaces, sanitary and drinking facilities are provided for the convenience of the traveler.

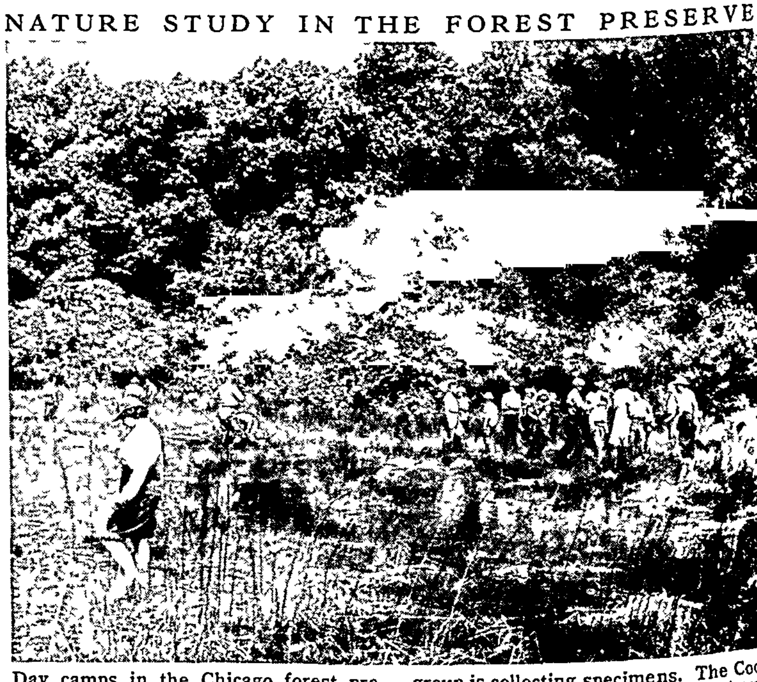
The new and rapidly developing school park is a means of locating school and park facilities together in order to serve both school and public recreation needs.

Amusement parks feature a variety of commercial attractions such as miniature trains, roller coasters, and shooting galleries. They are operated for profit, usually by corporations or private business investors, but sometimes as a concession granted by the park department.

State parks number more than 3,500, with a combined total of more than 8 million acres. Three fourths of the population of the United States live within easy reach of these beautiful areas. It is possible on a transcontinental motor trip to find a state park for each night's rest and recreation. In the modern state park one may camp, swim, fish, and picnic. Winter sports are popular in the northern parks. The largest and most impressive of all are the national parks and monuments, the national forests and the wilderness areas, which total many millions of acres (*see* National Parks and National Monuments).

More than 1,300 municipalities own almost 650,000 acres of park property. Two thirds are within city limits, and one third in county and regional parks There are more than 15,000 playgrounds, with an annual attendance exceeding 370 million. Every year municipalities spend about 375 million dollars on parks exclusive of capital construction and improvements They spend some 50 to 75 million dollars annually for land, buildings, and improvements.

NATURE STUDY IN THE FOREST PRESERVES



Day camps in the Chicago forest preserves give underprivileged city children camping experience. This nature-study group is collecting specimens. The Cook County Forest Preserve District trains nature-study leaders in its camps.

The influence of parks and playgrounds in modern, congested urban living can best be understood by examining the system of the nation's second largest city.

Chicago's Park System

The extent and varied activities of parks can be seen in Chicago whose first park dates back to the middle of the 19th century. At one time there were 22 separate park districts in the city. These have been combined into a single department—the Chicago Park District. Functioning as a separate municipality, the Chicago Park District levies its own taxes, maintains its own 200 miles of roads, and employs its own police force. It operates 166 parks, 126 playgrounds, 100 field houses, 102 gymnasiums, 45 swimming pools, 13 beaches, 560 tennis courts, 20 day camps, 98 skating rinks, and 528 clubrooms. To these resources of the Park District are added 87 playgrounds provided by the Board of Education and 60 playgrounds operated by the Bureau of Parks and Playgrounds in the Department of Public Works. The forest preserves on the outskirts of the city are operated by the Cook County Forest Preserve District.

In recent years increasing emphasis has been placed on sports and the more active forms of recreation. Attendance at *organized* activities in the Chicago Park District exceeds 30 million annually. Some 12 million people play golf in Chicago's public parks every year, and 27 million swim in the park pools. Millions of people also use the archery ranges, baseball fields, day camps, dance pavilions, horseshoe courts, skating rinks and toboggan slides. All these services are provided at a public cost of about 20 million dollars a year, not including funds approved by the public for acquiring and improving land and buildings.

Playgrounds and Play Fields

Chicago's playgrounds are located in parks, on school properties, in housing developments, and sometimes on privately owned parcels of land. There are three basic types of playgrounds—the play lot, the neighborhood playground, and the play field.

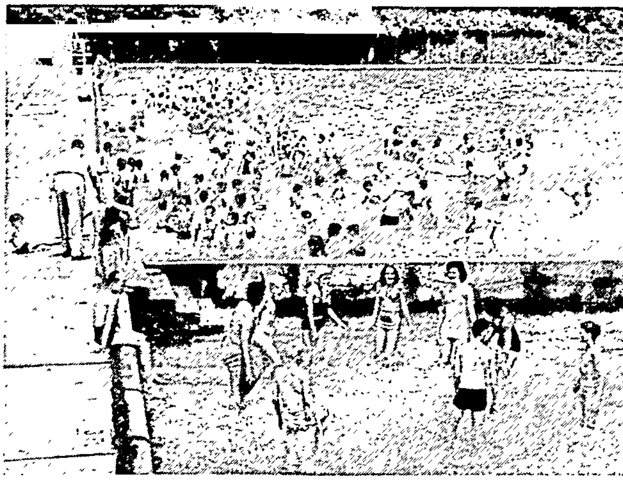
The play lot serves children of preschool age and is usually located in a densely populated neighborhood. Sometimes it is part of a larger playground or park. The play lot is fenced for safety. It contains swings, slides, "jungle gyms," and other play apparatus, and sandboxes and wading pools.

The neighborhood playground is the major outdoor recreation area for children of elementary school age. It provides play apparatus and space for children's games. In a well-equipped field house are facilities for woodworking and other arts and crafts, informal music, dramatics, club meetings, square dancing, and other community social affairs.

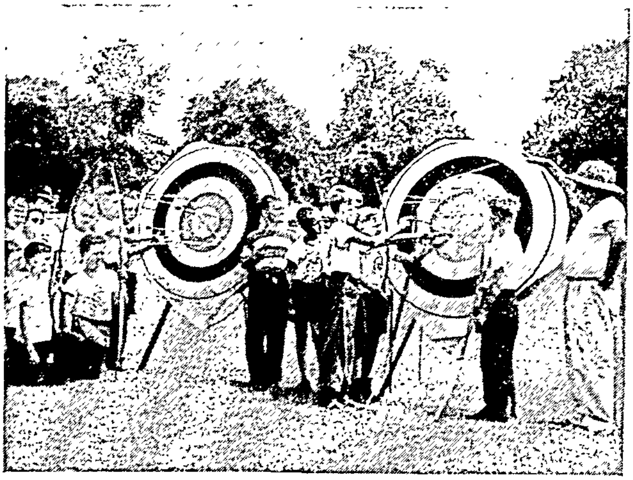
This area is at least three acres in extent and serves families living within a half mile of the playground. Day camps, where children can have camp experience and still return to their homes each night, are recent additions to many playgrounds.

The play field serves a population of from 15,000 to 20,000 people. It too may be a part of a larger park, and it may also provide playground space. It

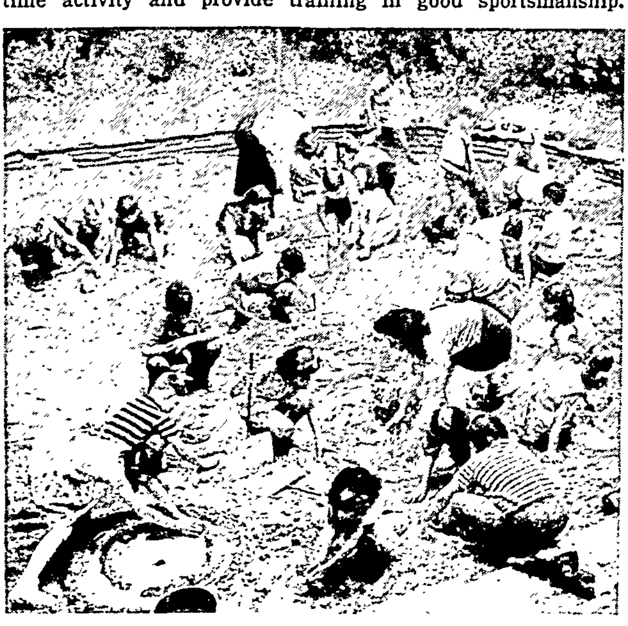
PARKS OFFER VACATION-TIME ACTIVITIES



In addition to Chicago's miles of beaches along Lake Michigan, the city has many wading and swimming pools in the west-side parks. Free instruction in swimming is available.



Archery is a popular sport. These boys are attending a day camp. Such camps provide children with healthful vacation-time activity and provide training in good sportsmanship.



Sand modeling develops a child's imagination and artistic abilities. Such park activities, under trained leadership, keep children happily occupied and help to develop character.

ARTS AND CRAFTS FOR LEISURE TIME

The girls in the picture at the left are making pilgrim and turkey posters for a Thanksgiving Day program. Two girls in the background are making papier mâché masks. Holiday programs and dramatic productions are given in the parks by neighborhood children. Woodworking for boys (right) is taught in well-equipped shops in the playground field houses.

includes facilities for sports such as baseball, softball, tennis, swimming, and track. Bleachers are provided for spectators, and there is a field house for indoor recreation. The larger play fields, more than ten acres in size, are lighted for night use.

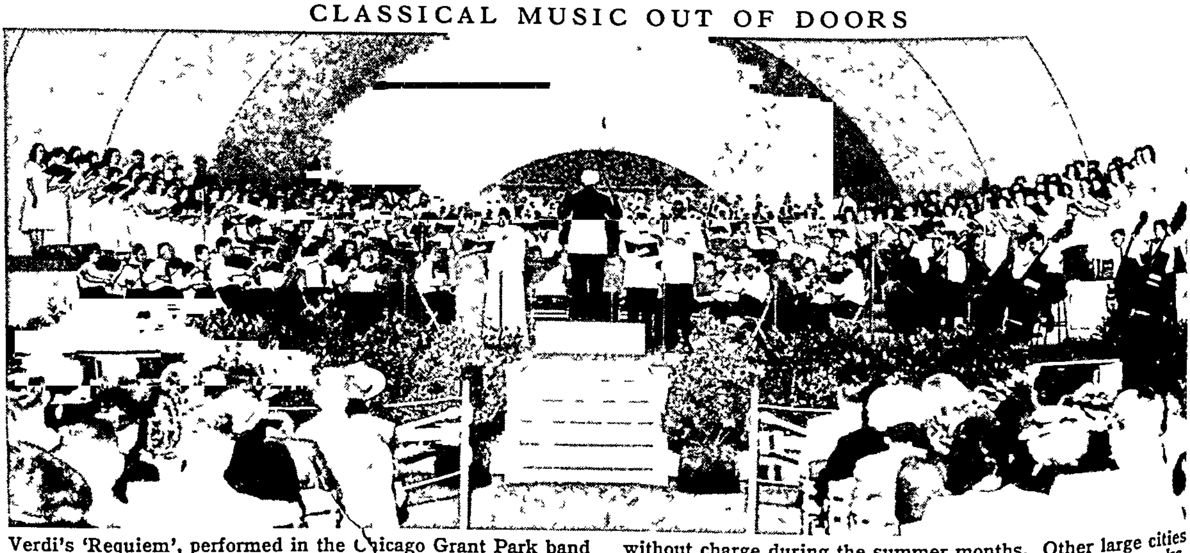
The Profession of Recreational Director

Parks require the services of gardeners and landscape architects, and of people to mow the lawns, trim the shrubs, and paint and repair the equipment. More important, they need trained personnel to direct the many recreational activities. The new emphasis on worth-while leisure-time activity has resulted in a rapidly growing profession—that of park, playground, and recreational director. These leaders know how to arouse interest, how to teach skills, and how to organize group participation. They direct not only sports and athletic events but musical and dramatic productions, pageants, square dances, and a great variety of handicrafts.

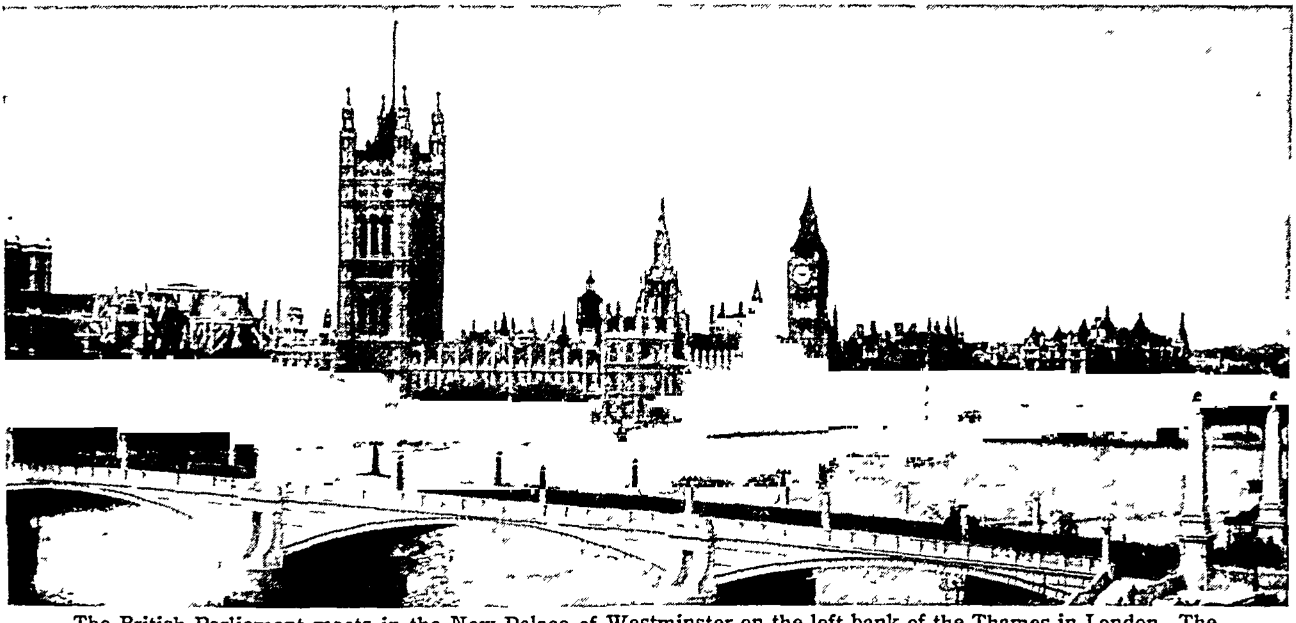
Today parks and playgrounds are to recreation and leisure time what the schools are to education and the church and synagogue are to religion. In the planning of the modern city or town, the location of parks and playgrounds is considered as important as the location of industrial plants, residences, public utilities, shops, and traffic arteries.

"Keep off the grass" signs have disappeared. Parks are in use throughout the year. Most playgrounds are open after school hours and in the evenings. Adult civic and social activities are carried on in the field houses. In short, the modern parks and playgrounds, once designed primarily to keep children off the street and to provide a quiet place of rest for working people, have become the center of neighborhood life.

CLASSICAL MUSIC OUT OF DOORS



Verdi's 'Requiem', performed in the Chicago Grant Park band shell, is typical of the excellent music offered Chicago citizens without charge during the summer months. Other large cities have similar outdoor concerts and operas in their public parks



The British Parliament meets in the New Palace of Westminster on the left bank of the Thames in London. The huge Gothic building spreads over eight acres. It contains more than 1,100 rooms and two miles of passages. From one corner rises the clock tower of Big Ben. The tall tower is Victoria Tower. At the left is Westminster Abbey.

The MOTHER *of* PARLIAMENTS

PARLIAMENT. The Parliament that has been making England's laws for more than 650 years is well called the Mother of Parliaments. Its two-house legislature has been the pattern for the lawmaking bodies of many other nations. The Canadian Parliament, for example, has a Senate and a House of Commons. The United States Congress consists of a Senate and a House of Representatives.

The British Parliament clings to many ancient traditions, like the woolsack on which the Lord Chancellor sits in the House of Lords. The king or queen may not enter the House of Commons. It is a terrible offense in the House to lock a door anywhere, to touch the mace on the clerk's table, or to cross the line between "government" and "opposition." When a vote is to be taken, the doorkeeper rings a bell four times. Then, to the shout of "Division!" the ayes walk out to the west lobby, the noes to the east lobby.

The House of Lords

The House of Lords has about 850 members. Of these about nine tenths are members because they hold hereditary titles. These titles, in order of their importance, are: duke (the highest), marquis, earl, viscount, and baron. Some of the peers are inheritors of old titles and landed estates. Others may be newly titled businessmen, lawyers, military officials, newspaper publishers, or labor leaders.

The remaining members hold their seats by right of office. They include the archbishops of Canterbury and York, 24 bishops, and 9 lords of appeal (commonly called law lords) who are appointed for life. The law lords handle legal matters that come to the House of Lords as a supreme court of appeal.

The House of Commons

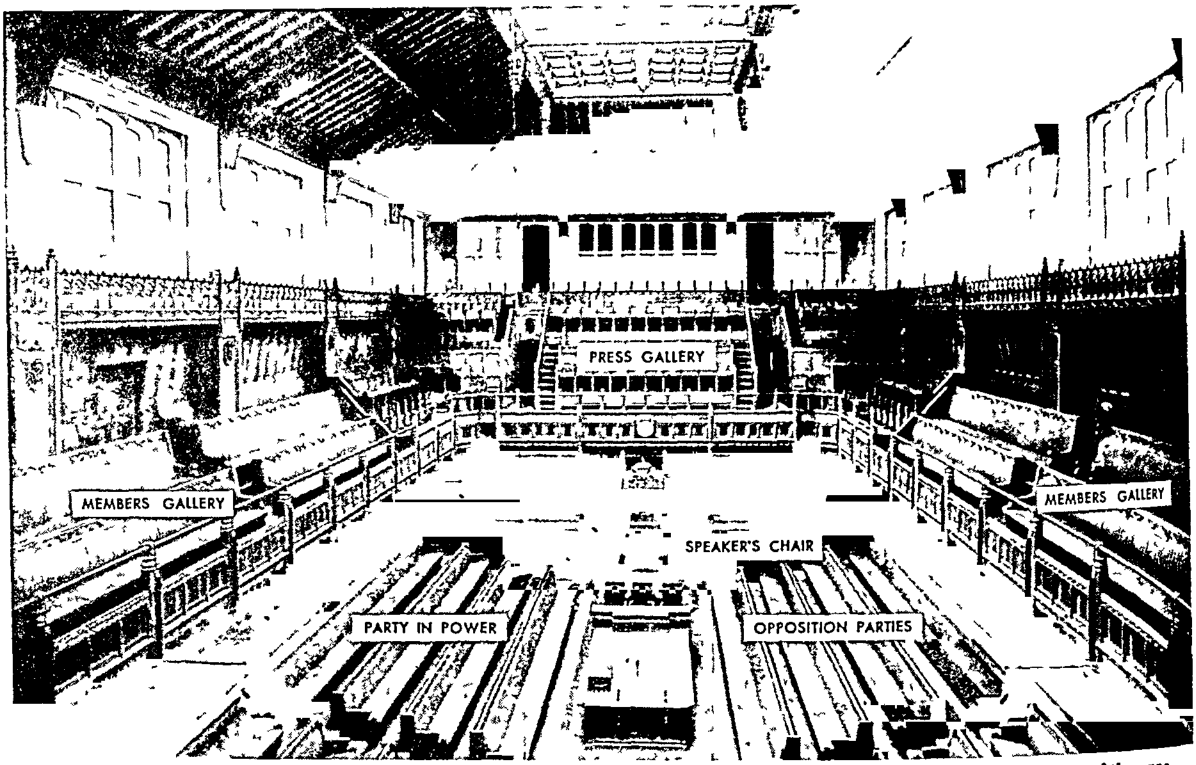
The House of Commons has more than 600 members, all of them elected. They represent constituencies (districts) throughout Great Britain and Northern Ireland, the country being divided so that each district has about the same population. A member may be elected from a district in which he does not live. In the United States a congressional candidate must be a resident of the district or state where he is running for office.

A law passed in 1911 provided that there must be a general election every five years for all members of the House of Commons. Before 1911 the length of time between general elections could be seven years. During a crisis, especially during wartime, a general election may be postponed. This happened during the second World War when the Parliament elected in 1935 carried on until the war ended ten years later. If a member dies or resigns his seat, a by-election is held in his district to select a successor. Since 1919 women as well as men have been members of the House of Commons.

Following the general election the ruler (now Queen Elizabeth II) appoints as prime minister the leader of the party that has the most members in the new House of Commons. He will hold office so long as he is supported by a majority (over half) of the members of the House. Sometimes the largest party has not a majority of the members. It will then have to depend on a coalition, that is, have the support of another party. If there is a national crisis a coalition may be formed to give stronger support to public policy. Winston Churchill, for example, was head of a coalition government during the second World War.

After his appointment the prime minister chooses the "government," that is, the members of his Cabinet and other prominent officials. The Cabinet members head such departments as the Foreign Office, the Home Office, the Admiralty (navy), the Exchequer (treas-

THE CHAMBER OF THE HOUSE OF COMMONS



This view, taken from the Strangers' Gallery, shows the historic chamber after its restoration in 1950. (The old chamber was burned out by incendiary bombs in 1941.) Leaders of the "government" occupy the bench at the Speaker's right; that on the left is for leading members of the opposition. At the table sit the clerk and two clerks-assistant On the table, when the House is in session, rests the ornate silver-gilt mace—the Commons' symbol of authority

ury), the Army, the Labour Office, and so forth (*see* Cabinet). All the members of the Cabinet must also be members of either the House of Commons or the House of Lords. The prime minister must be an elected member of the House of Commons.

Parliament must meet every year, particularly to provide the grants of money for carrying on the government. When a session opens, the king or queen attends in state to open Parliament formally. This state function is held in the House of Lords with the members of the House of Commons present. The ruler reads a speech that has been prepared by the heads of the party in power indicating some of the things the government plans to do.

A general election has to be held at least every five years. It may, however, be held at any time, if the party in power is voted down in the House of Commons (has a majority against it) on a major bill that is backed by the government. This is called a vote of "no confidence." If the government is voted down, a general election is held immediately in order to seek the judgment of the country as to which party shall control the new Parliament. The House of Commons may also be dissolved at the prime minister's request if he wishes to obtain the country's opinion on some important issue. For example, when the Parliament Act of 1911 was being considered, it was preceded by two general elections in 1910.

The business of each of the two houses of Parliament is carried on under regulations which we know as parliamentary law. These rules of order grew up through the centuries and are the chief basis on which present-day "rules of order" of numerous other societies are formed (*see* Parliamentary Law). A bill can be proposed either by the party in power or by any member on his own initiative, although the great majority of bills are presented by the governing party. With a few exceptions, a bill may originate in either house For a bill to become a law of the land, it must pass in both houses and be approved by the Crown (the king or queen). The ruler has the power to veto a bill that has passed both houses, but this right has not been used since the reign of Queen Anne (1702–14) The royal veto has, in practice, disappeared.

The Growth of Democracy

The long history, nearly seven centuries, of Parliament has brought about many changes in the form and power of the Lords and the Commons. In early centuries the House of Lords was much more powerful than it is today and was often called the Upper House. It grew out of the king's Great Council, composed largely of feudal barons.

The House of Commons took form in the 13th century when the lesser knights and representatives of the towns were called to meetings with the Great Council. By 1295, when the warlike Edward I summoned what has always been known as the Model Parliament, the Commons had become important. From the first, the Commons was a money-granting group (The kings always needed money, especially for carry-

ing on the wars that were so frequent in those days.) By the end of the 15th century the Commons had won the right to start all money bills, because the common people were by then the chief source of revenue for royal needs. By the middle of the 17th century the Lords no longer had the right even to modify money bills. The House of Lords, however, long kept the power to delay money bills and to vote down other measures that had been passed by the Commons.

Limiting the power of the House of Lords seemed more and more necessary as democratic ideas grew in recent centuries. The people felt that a nonelected Upper House should not hinder seriously the wishes of the House of Commons, elected as it was by the people. The Parliament Act of 1911 finally limited the power of the Lords by allowing it to delay a money bill only a month. This Act also provided that any other bill of the House of Commons that was rejected by the House of Lords became law if again passed by the Commons in three sessions, if two years had gone by between the first and the final passage of the bill. In 1949 this time was shortened to one year.

In early days the members of the House of Commons were selected by the shires (counties) and the boroughs (towns). There were two "knights of the shire" for each county, and two members for each town that had the right of sending members to Parliament. This arrangement seems to have arisen from the greater safety of two traveling together to London and from the need for having two members to see that neither went too far in accepting taxes for the town or county represented. The two-member system became out of date in the 19th century when great industrial cities such as Manchester and Birmingham had no representatives at all except through the county members where the town was located. Single-member districts have now largely replaced the older two-member representation, and the populations of the single-member divisions are now about equal.

British and American Governments Compared

Although the governments of Great Britain and the United States are both democratic, there are important differences. The British have no single written document such as the American Constitution. It is sometimes said that the British constitution is "unwritten," being made up of the many laws that Parliament has enacted over the centuries. A law passed by the British Parliament becomes constitutional by its very passage, whereas in the United States the Supreme Court may declare a law passed by Congress to be unconstitutional.

As we have already found, the British ruler no longer uses the power of the veto, but it is still used by the American president. The Senate of the United States is much more powerful than the Canadian Senate or the House of Lords. The Senate, of course, never consisted of a nobility, but was intended to give the states, especially the smaller ones, some check on the popularly elected House of Representatives. Like the House of Lords, the Senate cannot originate money bills, but it can amend and modify them.

The government of Great Britain is very democratic because the king or queen never interferes and the House of Lords has been deprived of much of its former power. As a result, the popularly elected House of Commons is, in fact, the ruler of Great Britain.

"*The* MEETING *Will Please* COME *to* ORDER"

PARLIAMENTARY LAW. Meetings of societies, clubs, or even legislatures would be chaos if they were not conducted by rules. These rules are known as *parliamentary law*. The name comes from the British Parliament, which originated the fundamental rules that still are used, with modifications.

When a group of people wish to organize a club, they first elect a temporary chairman and a secretary. Then a special committee is appointed by the chairman or by the assembly to draft a constitution, the framework of the organization, and by-laws, containing detailed rules for conducting business. These rules may be expanded when necessary. Some clubs work out the by-laws at meetings of the entire membership instead of in committee meeting.

The Constitution and Its Acceptance

The articles of the constitution usually set forth the club's name and object; qualifications for membership; method and time of electing officers; duties of officers; when meetings are to be held; amount of dues; how many constitute a quorum; how the constitution can be amended; and how many votes are required. By-laws may list duties of members, standing committees, and routine of business, which may be in the following order: roll call, reading of minutes of previous meeting, reports of standing and special committees, unfinished and new business, regular work of the club, and finally, motion to adjourn. As the secretary reads, section by section, the preliminary draft of the constitution and by-laws, or writes it on a blackboard, the club votes to accept or to amend it.

Duties of Officers and Members

Election of permanent officers is in order after the constitution and by-laws have been accepted. Officers are usually president, vice-president, secretary, treasurer, and perhaps sergeant-at-arms. Often the same person acts as secretary and treasurer. Many organizations have an executive committee made up of the officers and two or three other members, to decide important problems. Candidates for office are nominated from the floor, or by a committee. After all the candidates have been named, someone moves that the nomination be closed. Members then vote for the nominees, or perhaps for some unnamed member, usually by secret ballot. The candidate who gets the majority of votes is elected.

Standing committees, or permanent committees whose selection is usually explained in the constitution, and *special,* or temporary committees, appointed

by the president, club or committee chairman, do much of the specialized work of an organization.

Presiding at Meetings

If you are elected president, you open each meeting by saying, "The club will please come to order," or something to that effect. Then you proceed with the routine of business. A member who wishes to present plans or suggestions must rise, address the chair, and be recognized by you before he can make a proposal—called a *motion* in parliamentary law. You recognize him by facing him and saying, "The gentleman (or the lady) has the floor," or by merely calling his name. To whom shall you "give the floor" if two or three jump to their feet at once? You allow the maker of a motion to talk first on his motion, you recognize a person who has not yet voiced his views, or you favor a member who rarely has the floor. Always refer to yourself in the third person. For instance, instead of saying, "*I* appoint John O'Brien chairman of the committee," you should say, "*The chair* appoints John, etc." The president may vote always when the vote is by ballot or by yeas or nays, or otherwise when his vote will decide a question. He cannot debate a question unless he asks another officer or member to preside in his place while he expresses his opinions.

The president stands when stating questions, when presenting a question for vote, when reading vote returns, and when talking on a point of order. When a member has proposed a motion, the president states the motion and asks for a second. After the motion has been seconded, he asks, "Are there any remarks?" If there are none, he asks for the vote in some such form as this: "It has been moved and seconded that the club have a picnic at Hallowell's cottage on June 1. All those in favor signify by saying 'Aye'; those opposed say 'No'."

Then, after the vote he announces "The motion is carried (or is lost)."

PARLIAMENTARY MOTIONS CLASSIFIED

Privileged Motions

1. Time and place to reassemble.
2. To adjourn.
3. To take recess.
4. *Questions of privilege.*
5. Call for the order of the day.

Incidental Motions

1. Points of order.
2. *Appeal.*
3. The objection (requires two-thirds vote).
4. To read papers.
5. To divide a motion.
6. To withdraw a motion.
7. To suspend the rules (requires two-thirds vote).

Subsidiary Motions

1. To lay on the table.
2. To call for the previous question (requires two-thirds vote).
3. *To postpone to a definite time.*
4. *To refer to a committee.*
5. *To postpone indefinitely.*
6. *To amend the amendment.*
7. *To amend.*

These three motions are of equal rank.

Main or Principal Motions

All motions bringing up new business.

(Debatable motions are *italicized.* All others are undebatable.)

This table shows the various motions which may properly be made, classified as explained in the text, in order of precedence.

Keeping the Minutes

A secretary keeps the minutes, or records, of each meeting, and calls roll. In the minutes he records the kind of meeting (regular or special), date and place, presiding and recording officers, reading of minutes, business discussed, and time of adjournment. The members approve the minutes, amending them if necessary. The secretary reads all papers and calls the meetings when presiding officers are absent; he always stands when reading to the members. If the president is absent, the vice-president presides. The treasurer takes charge of the club funds. The sergeant-at-arms keeps order.

The members are the true rulers of a club. Without their consent, no measure can pass. A member who wishes to have the floor always stands and addresses the presiding officer as Mr. or Madam Chairman or Mr. or Madam President. Wishing to make a motion, he says, for example, "I move that the club have a picnic at Hallowell's cottage on June 1." Another member may say, "I second the motion," without rising. Voting is possible only if a *quorum* is present. A quorum is the minimum number of members required by the constitution to conduct business, in club meetings, or in specified committees.

"Class Distinctions" in Motions

Motions or proposals submitted are classified to avoid confusion in case several questions come before the house at once. Privileged motions claim first attention, incidental motions come second, subsidiary motions third, principal motions last. *Privileged motions* deal with the rights of members. A motion fixing the time or place at which to reassemble takes precedence over every other possible question. Lesser privileged motions, in order of precedence, are those to adjourn; to take a recess; to rise to a question of privilege (to secure the comfort of the club if the room gets too cold, for instance); or to call for the order of the day, that is, to bring up scheduled business when time is growing short. All privileged motions except that of questions of privilege are undebatable, and must be put to vote by the president before other questions that may be under discussion at the time.

Making "Points of Order"

Incidental motions, rising out of other motions, relate, in the order of their precedence, to points of order (a member is privileged to call the attention of the president to errors in parliamentary procedure, and the president decides whether the point is, or is not, well taken); to an appeal (a member may appeal to the assembly if he believes the president wrong in his decision on a point of order); to objections (a member may object to consideration of a trifling principal motion); to reading of papers; to dividing or withdrawing motions; and to suspending the rules (only parliamentary rules and special club rules may be suspended, never constitution or by-laws). An appeal is the only debatable incidental motion.

Subsidiary motions include, in order of precedence: to lay on the table (to postpone a discussion until later) or to take from the table; to call for the previous question (in order to cut short debate and bring a question to vote); to postpone to a definite time; and to refer to a committee. Three subsidiary motions of equal rank are postponing a subject indefinitely, amending a motion, and amending an amendment. All subsidiary questions, except to lay on the table and to call for the previous question, are debatable.

Motions Out of Order

Principal motions include chiefly main motions which bring up new business. All are debatable. A principal motion is out of order when any other question is before the club. A member might make the principal motion, "I move the club buy a picture for South Hall." While the club discusses this, another member might suggest, "I move the club send flowers to Miss Seymour." The second motion would be ruled "out of order" by the president because a previous principal motion was still before the club. However, while the motion to buy the picture is debated, a member might say, "I move the matter be referred to a committee." Since the motion to refer to a committee is a subsidiary motion, it claims precedence over any principal motion, and the club must drop its picture debate and accept or reject the committee motion.

Suppose, however, that before the club can vote on the committee motion, another member moves that the assembly take a recess. The club must then immediately turn from the committee question to the recess question. The motion to take a recess is a privileged motion and usually claims attention over motions of any other class. It must be put to vote immediately.

Moving and Seconding

Motions must be seconded, as a rule, before any vote is taken. A motion that fails to pass may be "reconsidered" later. Only motions changing a regulation or custom require a two-thirds majority; all others call for a mere majority. A motion presented to the club by the president becomes a *question*. After it has passed, a question becomes an *order* if it is a command; otherwise it is known as a *resolution*.

Voting is carried on by ballot, by a rising vote, by a chorus of "ayes" and "noes" (or "yeas" and "nays"), or by a raising of hands.

Authoritative reference works on parliamentary law are 'Parliamentary Law' by F. M. Gregg and 'Rules of Order' by Brig. Gen. Henry M. Robert.

Parnell, Charles Stewart (1846–1891). For more than ten years cold, handsome Charles Stewart Parnell was called the "uncrowned king of Ireland." During this time he led Irish members of the British House of Commons in constant battle for Irish self-government. Parnell failed in this Home Rule fight, but he helped lay the foundation for the present Republic of Ireland (*see* Ireland).

Parnell had little in common with his Irish Catholic fellow-countrymen. He was a Protestant of mixed Anglo-Irish and American ancestry. Moreover, he was a wealthy landowner and had nothing to gain personally by the reforms he sought. But he hated the English, and he worked furiously in the Irish cause.

Parnell was born June 27, 1846, at Avondale in County Wicklow, Ireland. He was educated in private schools and at Cambridge University. In 1875 he was elected to Parliament. He at once threw himself into the fight for Home Rule. Irish party leaders had failed to win English support by friendly means. So Parnell began a policy of obstructing and delaying all business of the House, hoping to force the English members into favoring Home Rule. He was a shrewd parliamentary tactician, and in 1877 he became leader of the Irish party.

Measures to relieve famine-stricken Irish peasants failed, and landlords set out to drive tenants from their holdings. Under Parnell's guidance a policy of "boycott" was adopted all over Ireland (*see* Boycott). Landlords who had evicted tenants found they could not get new tenants. The government passed a Coercion Bill to force obedience to the law. Parnell answered with more obstruction.

Parnell was jailed for his opposition tactics; but still further disorders brought compromise. He was released. Home Rule was then almost in sight when the chief secretary of Ireland and the undersecretary, both British, were assassinated in Phoenix Park, Dublin. The shocking murders set back the Irish cause; and the old quarrels began again.

In 1887 the *London Times* printed a series of articles accusing Parnell of encouraging Irish violence. It reproduced a facsimile letter in which Parnell supposedly approved the Phoenix Park murders. Parnell denied the charge; finally a forger confessed having written the letter and having sold it to the newspaper. This vindication increased Parnell's prestige; and again Home Rule seemed to be near realization.

But in 1890 William O'Shea, one of Parnell's party aides, sued his wife for divorce, naming Parnell. The divorce was granted, and Parnell soon married Katherine O'Shea. The divorce charges created a storm of protest in both England and Ireland, and the Irish party dismissed Parnell. He died Oct. 6, 1891, leaving Ireland under divided leadership.

Parrots, Macaws, and Cockatoos. Few birds are more brilliantly feathered, more screamingly noisy, or cleverer in the use of beak and claw than members of this closely related group. Including the macaws and cockatoos with the parrots, there are about 560 species of these gorgeous birds. They inhabit South America, Africa, the East Indies, Australia, and New Zealand.

All the species have a large arched upper beak, and all have two toes which point forward and two backward. Most parrots have harsh screaming voices. Some have the power of mimicking speech and can be taught to speak a few words. The gray parrot of Africa is most easily trained to talk. Parrots are good climbers, strong fliers, but clumsy walkers. They usually nest in hollow trees and are said to mate for life. They endure cage life well. They are long-lived, some living 70 years.

PROMINENT MEMBERS OF THE PARROT FAMILY

The rose cockatoo (upper left) is distinguished by a head crest. The two cuddling at the upper right are lovebirds, the midgets of the parrot tribe. Among the giants of the parrots is the red macaw (lower left). The green amazon (lower right) is best known among the American parrots that can be taught to speak. This painting is by Marshall Smith.

About 190 species of parrots inhabit the New World. Only one is found in the United States. This is the thick-billed parrot which occasionally enters Arizona from Mexico. The Carolina and Louisiana parakeets once lived in great numbers in the eastern United States from Florida to the Great Lakes, but these beautifully plumaged birds were exterminated: by milliners for their plumage, by sportsmen, and by farmers because the parakeets ate orchard fruit.

South American forests abound with these bright-colored birds. The blunt-tailed parrot, a common parrot of the zoos, is a native of the Orinoco territory. It has a bright green color with blue on the head and markings of red or yellow on throat and wings. The macaws are a long-tailed group of larger parrots, numbering about 15 species. They are found in Paraguay and Brazil. The macaws are the most gorgeously colored members of the parrot group. The red and blue is one of the handsomest.

Cockatoos and Other Varieties

The cockatoos, found in the Australian regions, are similar to the parrots in habit. They thrive in captivity and may be taught a few words, but are more apt to use their voices in screaming. The plumage of the cockatoo is generally white tinged with red, orange, and other colors. Most species have a large crest of feathers that can be raised to a height of as much as five inches, but which lies smooth when the bird is quiet. These birds fly about in flocks of 100 to 1,000 and are very destructive to grain fields.

The lory is a species of parrot with an extensible tongue for taking flower nectar. In New Zealand lives the kea, an olive-green parrot which attacks and kills sheep by thrusting its powerful beak into the fat which surrounds the kidneys.

Lovebirds are tiny African parrots, no larger than sparrows, but of pretty colors. They get their name from the affection they show each other. They are often kept as cage birds.

Parrots, macaws, cockatoos, and their allies form the order *Psittaciformes.* Scientific name of gray parrot, *Psittacus erythacus;* Carolina parakeet, *Conuropsis carolinensis carolinensis;* Louisiana parakeet, *Conuropsis carolinensis ludovicianus;* blunt-tailed parrot, *Chrysotis amazonicus;* thick-billed parrot, *Rhynchopsitta pachyrhyncha;* blue-and-yellow macaw, *Ara ararauna;* red-and-blue macaw, *Ara macao;* sulphur-crested cockatoo, *Cacatua galerita;* funeral cockatoo, *Calyptorhynchus funereus;* kea, *Nestor notabilis;* Australian lovebird, also called budgerigar, *Melopsittacus undulatus.*

Parsnips. The parsnip (*Pastinaca sativa*) is a hardy biennial plant—that is, it forms its fleshy carrot-shaped root the first year but does not produce any seed until the second summer. Then the plant springs up quickly from the root and sends a branching stem up among the leaves, topped with many greenish-white little flowers. The root, which is eaten the first season, is thick and whitish and has a peculiar but agreeable flavor, sweet but slightly acrid. The root often grows to a length of 18 inches and a diameter of 3 or 4 inches at the crown. Besides being cultivated as a vegetable the parsnip is highly valued as a food for live stock, particularly in Europe. The roots usually are left in the ground in the autumn, as they are improved by the frost. When stored they soon shrivel and become tough unless they are kept moist.

In Europe the plant has been cultivated since Roman times. A wild form of parsnip without the edible root grows as a troublesome weed in waste places of Europe, the United States, and Canada.

Pasadena, Calif. A superb location overlooking San Gabriel Valley gave Pasadena its poetic name. In the Indian language Pasadena means "crown of the valley." To the north the Sierra Madre rears its bare heights; and ten miles to the southwest lies the busy city of Los Angeles. The climate is dry and warm Average January temperatures are 52° F. and July, 73°. About 21 inches of rain fall each year. Pasadena has taken full advantage of its site and weather to become a beautiful residential suburb and a tourist center that attracts thousands yearly.

On New Year's Day, Pasadena holds a great floral festival called the "Tournament of Roses." The climax of the day is a football game played in the Rose Bowl between two outstanding college teams (*see* Football). The Rose Bowl is located in Brookside Park at Pasadena's west boundary. North of Pasadena lie

GATHERING FOR THE ROSE BOWL GAME

At Pasadena's famed Rose Bowl, crowds of nearly 100,000 pack the stadium for a New Year's Day football game after watching the floral pageant. Spacious parking for automobiles is provided. The Rose Bowl is used for other football games and for community events throughout the year.

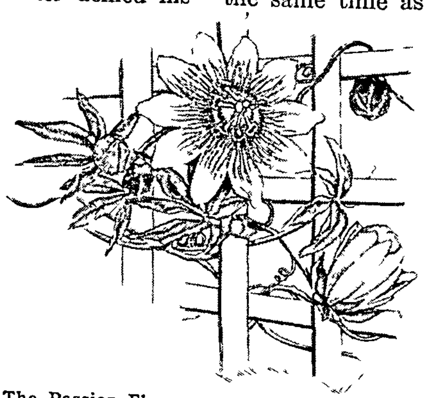
Mount Wilson and its observatory. Six miles to the southeast is the old San Gabriel Mission. In San Marino, just outside the southern limits, is the Henry E. Huntington Library and Art Gallery, which holds rich treasures of rare books, manuscripts, and paintings.

Pasadena's schools of higher education include the California Institute of Technology, two city colleges, and the Nazarene Pasadena College. The Institute is one of the world's great research centers. The Pasadena Playhouse has a noted dramatic school. Industries include citrus-fruit packing and the manufacture of scientific and precision instruments, art objects, chemicals, shoes, optical goods, and printed matter.

Pasadena was settled in 1874 by a group of wealthy men from Indiana, who sought an agreeable climate. The town was incorporated in 1886 and chartered by the state in 1901. The government is headed by a board of seven members elected for four-year terms; the board employs a city manager. Population (1950 census), 104,577.

PASSION FLOWER. When the Spanish settlers were roaming through South and Central America they found a flower so symbolic of the Crucifixion that they named it the "flower of the Passion." In the five-parted purple or lavender blossoms with stripes of white they saw the crown of thorns and the five marks of the wounds of Our Lord. The styles were the three nails and the stamens were the hammer that drove the nails into his hands and feet. The floral leaves were the ten apostles, Judas and Peter being absent, the one having betrayed and the other denied his master. The leaves were the hands of the persecutors and the clinging tendrils the scourges.

The plant of the North American passion flower is shrubby and climbing, being somewhat troublesome in the southern cotton fields. Some of the South American species are cultivated for the pale yellow berries, of the size of a small apple. The root of some species is poisonous and acts like morphine. Other species are planted that they may crawl and twist over our arbors and verandas.



The Passion Flower or common Maypop of the Southern states.

Scientific name of common passion flower of the Southern states, *Passiflora incarnata.* Flowers solitary, white or purple, 2 inches across, with 3 bracts beneath the flower; 5-part calyx colored like petals; 5 sepals with which is a crown of numerous rays forming a fringe; 5 stamens; 3 styles and capitate stigmas; leaves alternate, 3-lobed, cordate-ovate, serrate; stem trailing or climbing by tendrils.

PASSOVER. With tears and rejoicing, with song and praise, the Jews through many centuries have celebrated the festival of freedom, which commemorates their deliverance from Egypt. Round the festal board on the eve of the Passover, the family gather to rejoice and thank God for his preservation of their people.

The father of the family sits at the head of the table, which is spread with the best linen and adorned with the best of the family plate. Before him are symbols such as have been used since ancient times to explain the story of the Passover. First of all, there are three flat loaves of *matzoth*, or unleavened bread. This is a reminder of the haste with which the Israelites were forced to leave Egypt; they had no time to make provision for the journey or to allow their bread to rise, but had to carry the unleavened dough with them and bake it on the way. A roasted lamb bone and a roasted egg commemorate the burnt-offering which the Hebrews were commanded to offer, when God promised to pass over their houses and spare their first-born. Another dish contains a portion of horse-radish or other bitter herb, used to represent the bitter life of the Israelites in Egypt; and a paste of nuts, apples, and spices, made to resemble clay or mortar used in building, is a sign of the heavy toil exacted by the Egyptians.

These symbolical dishes are tasted at stated times, while the father reads from the Talmud legends of the forefathers, miraculous stories, prayers, and songs, in which the rest of the family often join.

It is the custom for the youngest child in the family to ask questions about the meaning of the celebration, and these are answered by the father. The whole ceremony is designed to appeal especially to the young, not only in its serious side, but in the games, songs, and stories that make the time pass merrily.

The Jewish Passover falls in the early spring, about the same time as the Christian Easter. The Last Supper of Christ and his disciples was the opening feast of the Passover. The date of the Passover is not determined in the same way as that of Easter, however; hence they do not always come together. Passover begins on the 14th of the Jewish month of Nisan, and lasts till the 21st. Only unleavened bread is eaten during the week and the first and last days are kept as holy days. The Orthodox Jews keep eight days instead of seven, observing the first two and the last two days as holy days.

PASSPORT. All persons traveling in foreign countries should take passports with them. These are documents issued by their governments certifying to their citizenship and asking foreign governments to give them all lawful aid and protection. Even in the few countries which do not require passports for admission, they are useful as evidence of nationality and proof of identity.

Before a traveler leaves the United States he should obtain a "visa" or official endorsement from the consular agents of the various countries he is about to visit. This is required by all except a

few countries. Some governments grant visas free, but most make a charge ranging from $1 to $10.

In the United States passports are issued by the Department of State. There are passport offices in Washington, D. C., New York City, Boston, Chicago, New Orleans, and San Francisco. Passports are also issued by consular offices abroad. A pamphlet called 'Essential Requirements When Making Application for Passport' can be obtained from any passport office. The passport itself contains a description and a photograph of the bearer. A passport is valid for two years and may be renewed for an additional two years. The original cost is $10, for renewal $5. Families with children under 21 may travel on a *family passport.* The word passport is derived from the French *passer,* "to pass," and *port,* a "port" or "harbor."

PASTEUR *and His* FIGHT *against* GERMS

PASTEUR, Louis (1822–1895). A little French chemist, Louis Pasteur, was one of mankind's greatest benefactors. Pasteur devoted his life to solving practical problems of industry, agriculture, and medicine. His discoveries have continued to save countless lives yearly and to create new wealth for the world. Among them are the pasteurization process and preventives against silkworm diseases, animal anthrax and chicken cholera, and the dread disease rabies.

Pasteur lived for science and the good that it could do. He sought no profits from his discoveries, and he supported his family on his professor's salary or on a modest government allowance. In the laboratory he was a calm and exact worker; but once sure of his findings, he vigorously defended them. Pasteur was an ardent patriot, zealous in his ambition to make France great through science.

"The child will live!" Louis Pasteur tells the grateful mother of little Joseph Meister and his attending physician, Dr. Grancher. The boy had been bitten by a rabies-infected dog. He was the first human being to be treated by Pasteur's new rabies vaccine.

Scholar and Young Scientist

The father of Louis Pasteur was a tanner who had fought under Napoleon. Louis was born Dec. 27, 1822, at Dôle in the Jura Mountains of eastern France. Five years later the family moved to near-by Arbois, where Louis went to school. He was a hard-working pupil, but not especially brilliant. His main interest for a time was art, and his early portraits show genuine talent.

When he was 17 he received a degree of bachelor of letters at the Collège Royal de Besançon. For the next three years he tutored younger students and prepared for the École Normale Supérieure, a noted teacher-training college in Paris. As part of his studies at the school he investigated the difference between two apparently similar acids, tartaric acid and racemic acid. He found that the difference was one of crystal formation (*see* Tartaric Acid). The discovery brought him recognition and an appointment as assistant to a chemistry professor.

Pasteur won his doctor of science degree in 1847 and was appointed professor of chemistry at the University of Strasbourg. Here he met Marie Laurent, daughter of the rector of the university. They were married in 1849. Marie Pasteur shared his love for science. They had five children; three died in childhood.

Research in Fermentation and Souring

In 1854 Pasteur became professor of chemistry and dean at the school of science (Faculté des Sciences) at Lille. Hearing of Pasteur's ability, a local distiller

came to him for help in controlling the process of making alcohol by fermenting beet sugar. Pasteur saw almost at once that fermentation was not a simple chemical reaction but took place only in the presence of living organisms. He learned that fermentation and such similar processes as putrefaction, infection, and souring are caused by germs, or microbes.

Pasteur published his first paper on the formation of lactic acid and its function in souring milk in 1857. Further studies developed the important technique of pasteurization (*see* Milk). The same year he was appointed manager and director of scientific studies at his old school, the École Normale Supérieure. During the next several years he extended his studies into the germ theory. He spent much time proving to doubting scientists that germs do not originate spontaneously in matter but enter from the outside. One early student of his writings was the English surgeon, Joseph Lister. From Pasteur's researches Lister developed modern sterilization methods in the operating room (*see* Antiseptics).

Saving Animal and Human Life

In 1865 Pasteur was asked to help the French silk industry, which was near ruin as a result of a mysterious disease that attacked the silkworms. He sought the cause and the cure and after intensive research discovered that there were two diseases involved, both caused by bacteria on the mulberry leaves which provided food for the worms. The diseases were transmitted through the eggs to the next generation of worms. Pasteur showed the silkworm breeders how to identify healthy eggs under the microscope, how to destroy diseased eggs and worms, and how to prevent formation of disease bacteria on the mulberry leaves.

At 45, Pasteur was struck by paralysis. For a time recovery was uncertain, and he was confined to bed for months. The attack left its mark; for the rest of his life, one foot dragged a little as he walked.

In 1877 Pasteur began his fight against anthrax, a disease that destroyed cattle, sheep, and other farm animals. Before he found a cure, he began research on another animal disease, chicken cholera. He inoculated healthy chickens with weakened cultures of the cholera microbes. The chickens suffered only a mild sickness and were thereafter immune to the disease. Pasteur applied this technique of *immunization* to the prevention of anthrax and was successful.

Many scientists challenged Pasteur's anthrax prevention claims. Pasteur agreed to a dramatic test. Forty-eight sheep and a few cows and goats were gathered in a pasture near the town of Melun. About half of the animals were first immunized with cultures of weakened anthrax microbes; then all were injected with strong cultures. Within a few days, the untreated animals were dead; but the immunized animals showed no effect of the disease. Pasteur's triumph was complete. Speaking in London, a short time later, he proposed that all inoculation cultures be called *vaccines* and the technique, *vaccination*. Both terms are derived from *vacca* (Latin for "cow)." These names, said Pasteur, would honor the Englishman Edward Jenner, who had first used vaccines of cowpox as a preventive against smallpox (*see* Jenner; Vaccination).

Pasteur Conquers Rabies

Human beings contract rabies when they are bitten by a "mad" dog or another animal with the same disease. Rabies, or hydrophobia, slowly destroys the central nervous system by attacking the spinal cord. Doctors knew no cure for rabies; and many afflicted people died in agony. All over France people feared the disease and they appealed to science to find a cure.

Pasteur reasoned that it might be possible to immunize a person *after* he had been bitten but before destruction of the spinal cord began. He took spinal cord tissues of animals dead of rabies and dried them for varying periods of time. He then made inoculations of the tissues and injected them into another stricken animal. The first inoculation was from the driest and weakest; each later one was successively stronger. He tried over and over; at last he won. He halted the development of rabies in an infected dog by giving it 14 inoculations of the tissue.

Pasteur hesitated to try the remedy on humans. But the decision was forced on him in 1885 when the mother of Joseph Meister begged Pasteur to save her son. The nine-year-old boy had been bitten 14 times by a mad dog. Pasteur treated the child. The wounds healed and no trace of rabies appeared. Thus Joseph became the first person saved by Pasteur's treatment.

Pasteur had won many honors for his previous discoveries; now the world united to do him special homage. Thousands of people contributed funds to establish a great laboratory, the Pasteur Institute. There scientists still carry on the fight against disease. But Pasteur's work was nearly done. Old and worn out by his labors, he died near St. Cloud Sept. 28, 1895.

PATAGONIA. The southern part of the continent of South America, from the Rio Negro south to the Strait of Magellan, is known as Patagonia. From north to south it is about 1,000 miles long. In 1881 the area was divided between Chile and Argentina. The Chilean section, a narrow, heavily wooded strip falling westward from the Andes, is now called the Magallanes. Ranchers run many cattle over this well-watered mountain area. Argentina's section, about 300,000 square miles, comprises almost one-third of the country. It is a vast, wind-swept plateau, at the highest point about 5,000 feet above sea level. Most of the arid plateau receives less than ten inches of rain a year. Irrigation is used to raise some cereals. Sheep are run over the whole area.

Patagonia was discovered in 1520 by Ferdinand Magellan. Few settlers came until after the middle of the 19th century, and Patagonia remains sparsely settled The Indian natives have a primitive culture. (*See also* South America; Argentina; Magellan.)

PATENT. *To patent* means *to reveal.* The word comes from the Latin *patere*, meaning "to be open." An inventor *reveals* the details of his invention to the patent office. If they are new, a patent is granted him. The owner of a patent has the sole right to make and sell the patented article.

The right of Americans to patent inventions comes from the Constitution. This gave Congress authority "to promote the progress of science and useful arts" by means of patents. In 1790 Congress created a patent commission consisting of the secretaries of war and state and the attorney general. Today the Patent Office is a part of the Department of Commerce.

The first United States patent was issued on July 31, 1790, to Samuel Hopkins of Vermont. This enterprising Yankee had invented a new way of treating wood ashes to produce lye for making soap. George Washington signed his patent as president, Thomas Jefferson as secretary of state, and Edmund Randolph as attorney general.

Between 1790 and 1836 the government granted almost 10,000 patents. In the next hundred years it granted 2,000,000 patents. Today the United States leads the world in the number of its patents, with 40 to 50 thousand granted in most years.

Some Queer Inventions

Naturally not all this vast accumulation of patents represent valuable inventions. One patented device is designed to enable a man buried alive to signal to people outside. Another attempts to render trains collision-proof by means of rails running over the roof so that one train overtaking another would run over the top instead of colliding with it. Hundreds of men and women have clung to the impossible dream of inventing perpetual motion, but since none of them were ever able to furnish a working model, their applications were never granted.

When we compare countries as to the success and importance of their inventions, the result is the same —the United States easily takes the first place. No one has ever worked so hard to save labor as has the American. The greatest of all labor-saving devices, the sewing machine, is chiefly his, and outside of the textile industry (in which England is preëminent) practically all of the great advances in labor-saving machinery have been of his invention—the cotton gin, the reaper, shoe machinery, the typewriter, and typesetting machines. The three most signal advances in electrical application are also to his credit—the telegraph, the telephone, and the incandescent lamp—and the Patent Office also contains a model of Wright's first airplane.

A Standard for all the World

The institution of the American Patent System, established in 1836, created a revolution in the method of granting patents and became the standard for the whole world to follow. It provided that patents should be issued only after a thorough examination into the usefulness and novelty of the inventions, thus avoiding endless duplication and lawsuits. Greater emphasis was placed upon the right of the inventor to have this invention rewarded, and relatively less upon the benefit which the public would derive from it. Experience has shown that no reward was so fitted to the achievement and so productive of the common welfare as to allow an inventor a monopoly of his invention for a limited time. In 1836 the erection of the Patent Office was begun, and in a short time American inventions increased by leaps and bounds.

The inventor who wants a patent must submit to the Patent Office a written description and drawings of his invention, together with special claims for it, and an application fee. He must also declare upon oath that he believes the invention to be an original one. If the idea is judged to be new, the patent is issued on payment of an additional fee, and the inventor then has sole right to make and market the invention for 17 years. If anyone infringes upon his rights—that is, makes or sells his patented article—he can compel the infringer to stop and to pay damages. Patented articles must always be marked "patented," with the date of issue or serial number. If an inventor does not wish to make use of his patent, he may "dedicate" it to the people of the United States. Anyone may then manufacture the patent without obtaining a license or paying royalties.

By international agreement all the citizens of the principal countries share the same patent rights. During time of war patents of citizens of enemy countries may be seized like their other property.

The term "patent" is also applied to a title to land which the government gives the homesteader.

PATERSON, N. J. This important industrial city, 17 miles northwest of New York City, owes its origin largely to Alexander Hamilton, who dreamed of making the United States economically independent of Europe by building up its manufactures. Realizing the possibilities for abundant water power at the Great Falls of the Passaic River, with its drop of 70 feet, he organized the Society for the Establishment of Useful Manufactures. The society founded a town on the site in 1792 for the manufacture of textiles, naming it for William Paterson, then governor of New Jersey.

For many years Paterson was a "one-industry" city. First cotton, then iron machinery, locomotive building, silk, and aeronautics in turn were the primary sources of income. Since the late 1930's, however, the situation has changed. The city now has more than 700 industries, making a wide variety of products. Among these are textiles, machinery, clothing, chemicals, plastics, rubber, paperboard containers, and stained-glass windows.

A state teachers college, a fine public library system, and a museum, which has an outstanding collection of fluorescent minerals, all contribute to the cultural life of the city.

There are many fine parks and recreation areas covering about 150 acres. The first successfully operated submarine, designed here by J. P. Holland in 1881, is on display in one of the parks. Paterson has the mayor-council form of government. Population (1950 census), 139,336.

PATRICK, SAINT (385 or 386–461). The patron saint of Ireland, whose special day the Irish celebrate on March 17, was born in what is now Scotland. He lived in southwestern Britain in the troubled days when the Romans were abandoning the island to its fate,

and before the English had appeared, and was educated as a Christian. Then one day, when he was 16 years old, he was carried off by some wild Irish marauders and sold into slavery in Ireland. By serious study, he learned the Celtic tongue.

After he had served in Ireland for six years as a swineherd, he managed one day to escape in a ship that was going to Gaul (France). For a time he lived in Gaul, where he became a monk, and then returned to his home in Britain.

After his return he dreamed one night that a man came to him with a paper bearing these words, "The Voice of the Irish," and at the same time he heard the Irish calling, "We pray thee, holy youth, to come and walk again amongst us as before."

This Patrick decided was a missionary call to Ireland. He returned to Gaul, where he spent 14 years in preparing for his work. In 432 he arrived in Ireland with the title of bishop and the pope's blessing and began the work which was to make him the patron saint of the island.

It has been said that there "were no Christians in Ireland when Patrick began his work and no pagans when he died." This is not strictly true, but he did do much to establish Christianity firmly, building churches and monasteries and converting the people. And he did so while fierce tribal chieftains ruled the land and there was little peace or order.

Many legends grew up in Ireland about St. Patrick. There is the story of how he forced the snakes of Ireland to fling themselves into the sea. There is another story that when some converts questioned the doctrine of the Trinity, St. Patrick ended the argument by holding up a shamrock leaf as an example of "Three in One." It was claimed there was no night for 12 days after his death on March 17, 461, at the age of 75 or 76. Another legend says that he lived to be 120, the life span of Moses as given in the Bible. The latter legend accounts for the 493 death date.

PATRIOTIC SOCIETIES, UNITED STATES. Many societies have been formed to keep American traditions alive, to teach patriotism to American youth, and to help war veterans regain their place in a peacetime society. The earliest of these organizations was the Society of the Cincinnati, formed by Gen. George Washington and his American and French officers in 1783 to preserve their friendships and aid their return to peaceful pursuits (*see* Cincinnatus). The society still exists, with about 1,500 members, all male descendants of the original members.

Other groups have been formed to honor the memory of ancestors who fought in the Revolutionary War. These include the Sons of the Revolution (founded 1875); Sons of the American Revolution (1889); Daughters of the American Revolution (1890); and Daughters of the Revolution (1891). Similar organizations that commemorate early America are the Pilgrim Society (1820); National Society of Colonial Dames of America (1892); Society of Mayflower Descendants (1897); and Daughters of the Founders and Patriots of America (1898).

After each succeeding war, new veterans' organizations arose. In addition to keeping alive their comradeship and the traditions of military service, these groups took an active part in promoting laws to help the veteran and his dependents. In 1866 Union soldiers of the Civil War formed the Grand Army of the Republic (G.A.R.). Its membership, which numbered 409,489 in 1890, dwindled until only 16 were left at its last encampment in 1949. Affiliated with the G.A.R. was the Woman's Relief Corps (1883). This group, composed of women relatives of Union soldiers, was founded to honor the dead soldiers and to care for their dependents. Auxiliaries of the G.A.R. include the Ladies of the G.A.R., Sons of Union Veterans, and Daughters of Union Veterans.

Those who fought on the Confederate side formed the United Confederate Veterans (1889). Their descendants joined the United Sons of Confederate Veterans and the United Daughters of the Confederacy. Other Civil War groups were the Military Order of the Loyal Legion, Dames of the Loyal Legion of the United States, and Army Nurses of the Civil War.

During the latter part of the 19th century, more patriotic societies were founded. These included the Army and Navy Union (1886); Army and Navy Legion of Valor (1890); and Jewish War Veterans (1896). Men who saw service in the Boxer Rebellion in China joined the Imperial Order of the Dragon (1900).

The Spanish-American War veterans formed several organizations. The most important is the Veterans of Foreign Wars of the United States (1899). This group accepted men who fought in any foreign expedition of the United States. Veterans of the first and second World Wars have expanded its membership. Women who served in the armed forces are accepted in the V.F.W. auxiliary.

The largest of present-day veterans' organizations is the American Legion. It was founded after the first World War (*see* American Legion). This group also accepted veterans of the second World War and women who served in the armed forces. The American War Mothers, the American Gold Star Mothers, Inc., and the American Gold Star Mothers of the World Wars, Inc., were also founded about this time.

The Disabled American Veterans (1920) is a group of disabled veterans of both World Wars who banded together to obtain special medical care and vocational training from the government. This aid enabled many of them to overcome their handicaps and become self-supporting again.

During the second World War, two new veterans' groups were formed. The first was the American Veterans of World War II ("Amvets"). The Amvets accepted both men and women who served in the armed forces in the second World War. The second group was the American Veterans Committee (A.V.C.). The A.V.C. extended membership to all Americans who served in an Allied armed force during the war. War-time merchant seamen were admitted only as charter members. In 1950–51 membership in all these veterans' organizations was opened to veterans of the Korean war.

PATTON, GENERAL GEORGE SMITH, JR. (1885–1945). "We shall attack and attack until we are exhausted, and then we shall attack again." These words of Gen. George Patton symbolized the hard-driving leadership that helped make him the foremost tank specialist of the second World War.

His relentless attacks won him the nickname "Old Blood and Guts." But the general drove himself as hard as he did his men. He was constantly at the front inspiring his men by his own tireless example. He drew criticism for his blunt talk and sometimes tactless handling of men, but his brilliant battle successes won him respect.

Patton inherited his love of the military. His grandfather was graduated from Virginia Military Institute and later served as a Confederate colonel in the Civil War. His father also was graduated from VMI before turning to a law career.

A GENIUS OF TANK WARFARE

Standing beside a tank, General Patton watches one of his armored columns move out for high-speed, slashing action.

George Patton was born on the family ranch at San Gabriel, Calif., Nov. 11, 1885. In high school Patton was an expert horseman, fencer, and swimmer. At the age of 18 he entered Virginia Military Institute but after a year transferred to West Point. He was graduated from there in 1909 as a cavalry officer.

At the 1912 Olympic Games in Stockholm, Patton placed fifth as the United States representative in the modern pentathlon. His worst showing was in shooting the pistol. But he practised until he became an excellent marksman. He was famous for his pearl-handled revolvers. During the first World War he organized a training center for American tanks in France. Later he commanded a tank corps in the St. Mihiel and Meuse-Argonne offensives.

In the second World War Patton injected the spirit of the horse cavalry into mechanized warfare. His quick tank thrusts knifed through the enemy lines and upset defensive strategy. These slashing attacks brought spectacular victories in North Africa and Sicily. But it was as commander of the 3d Army in Europe that Patton won his greatest fame. In less than 10 months his armor and infantry roared through six countries—France, Belgium, Luxemburg, Germany, Austria, and Czechoslovakia. In all the 3d Army captured more than 750,000 Nazis and killed or wounded another half a million.

After the war Patton remained on duty in Europe. On Dec. 21, 1945, he died as a result of an automobile accident and was buried in Luxemburg.

PAUL, SAINT. Saul of Tarsus, fiery persecutor of the early followers of Jesus, was one day going down the road to Damascus to take prisoner all the Christians he could find there. Suddenly, according to the account of Acts ix, a great blinding light shone down on him, and a voice said, "Saul, Saul, why persecutest thou me?" Trembling, Saul asked, "Who art Thou, Lord?" and the voice answered, "I am Jesus, whom thou persecutest."

Saul, shaken and still blinded, proceeded on to Damascus, changed in spirit and name. For after that he called himself Paul and "straightway he preached Christ in the synagogues, that He is the Son of God."

Paul was a Roman citizen. His parents were prominent Jews of Tarsus who trained their son in the strict faith of the Pharisees. As a boy Paul learned to make tents, and later, on his preaching tours, he supported himself by tentmaking.

It is believed that Paul never saw Jesus in the flesh. After his conversion, when he was about 32, he meditated alone for months and then sought out Peter, chief of the disciples, to learn how Jesus had lived. On the strength of what he learned, Paul became one of the greatest missionaries of all time. He traveled Asia Minor and Greece, gaining converts and setting up churches.

His method was always the same. First he spoke in the synagogues, and when the Jews became hostile he would withdraw and organize a church of the Gentile-Christian order. This aroused the conservative element of the early Christians who did not agree with Paul that a man could be a Christian without first going through Jewish ceremonies. It was Paul who began to develop Christianity as a world-wide religion and who formulated the theology of the early *Christian Church.*

He so antagonized the Jews that when he returned to Jerusalem he was seized and thrown into prison, where he was kept two years. Finally he availed himself of his right as a Roman citizen and appealed to the Emperor Agrippa. He was sent to Rome and held there, a virtual prisoner, for two years more. According to tradition he was later beheaded by order of Nero.

The Epistles of Paul, which form a considerable part of the New Testament, are letters he wrote to his friends and to the various churches. The Book of Acts tells much about him and his work.

PAVLOVA or **PAVLOWA, ANNA** (1885–1931). "She does not dance, she soars as though on wings." That is what enchanted audiences the world over thought of Anna Pavlova. Throughout her career as the world's foremost *ballerina*, she was called "the incomparable Pavlova." Yet no dancer worked harder to perfect her art. Even at the height of her fame, small, slender Pavlova practised 15 hours a day.

Pavlova was born Jan. 31, 1885, in St. Petersburg (Leningrad), Russia. She and her widowed mother lived alone. They were very poor, but managed an occasional treat. When Anna was eight years old, her mother took her to a performance of Tschaikovsky's beautiful ballet 'The Sleeping Beauty' at the Maryinsky Theater.

THE INCOMPARABLE PAVLOVA

Anna Pavlova, in 'The Dying Swan', became the symbol of the dance to millions everywhere. Here she is in her beautiful, feathered swan costume.

"I was plunged into a world that surpassed my wildest imagination," Pavlova recalled years later. "With the first notes of the orchestra I was literally entranced. I could scarcely breathe." She determined to become a dancer. She was too young to enter the Imperial Ballet School, but was admitted two years later. Six years of hard work and merciless discipline followed. At 16 she was graduated and was given a part in the Maryinsky Theater *corps de ballet*. Before she was 20 she became *prima ballerina* and danced for the czar of Russia. The young dancer was acclaimed at once. She was not pretty, but her exquisite grace and her large dark eyes and delicate pointed face gave her a wistful beauty.

In 1910 Pavlova left Russia for a tour. She made appearances with Diaghilev's Russian Ballet, and eventually organized her own company. Young dancers found her a severe disciplinarian but a willing teacher. Often she would stop her own exercises to demonstrate a correct step. The world became her home. She bought a country estate at Hampstead Heath, near London, but spent little time there. Her marriage to her manager and accompanist, Victor Dandré, she kept secret for years. "The world likes to think of an artist as an illusion," she explained. "That is why I keep my private life to myself."

Among her many dances were 'Coppelia', in which she made her American debut at the Metropolitan Opera House in 1910, 'Autumn Leaves', 'Les Sylphides', and 'Glow Worm'. Most beloved of all was 'The Dying Swan', arranged for her by Michel Fokine. She died eight days before her 46th birthday.

PEA. A favorite vegetable and a beautiful garden flower are two of the best-known peas. The pea family (*Leguminosae*), also known as the bean or pulse family, includes the food plants—peas, beans, cowpeas, chick-peas, soybeans, lentils, and peanuts; the forage plants—clover, vetch, and alfalfa; and kudzu-vine, and furze, or gorse, used to bind soil and prevent erosion.

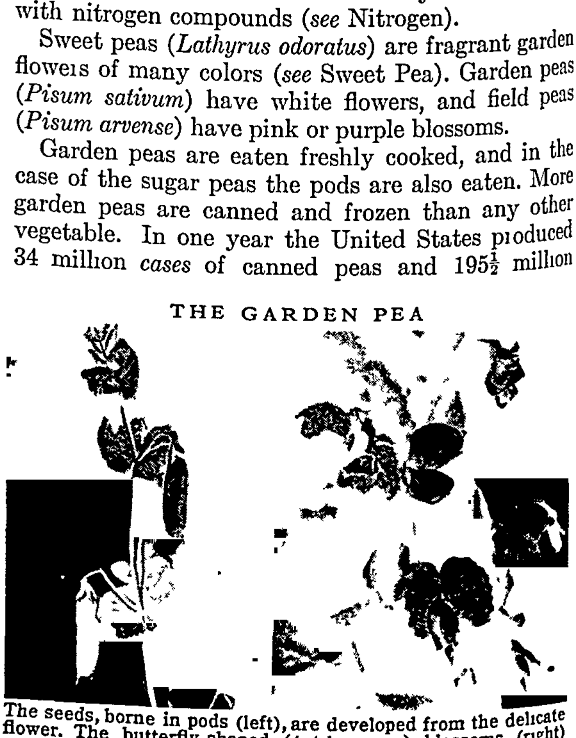
Among the wild flowers, weeds, and ornamental plants of the family are sweet peas, wistaria, mimosa, acacia, lupine, vetch, senna, indigo, locoweed, and licorice. Beautiful trees are the redbud, or Judas tree, locust, Kentucky coffee tree, and tamarind.

The plants have butterfly-shaped blossoms and seed-bearing pods. The leaves are nearly always divided into leaflets (compound), and the garden and field peas have tendrils by which they can climb as vines. The seeds produce a high proportion of protein. From time immemorial peas and beans have been the "meat," or protein food, of the poor. All members of the family enrich the soil with nitrogen compounds (*see* Nitrogen).

Sweet peas (*Lathyrus odoratus*) are fragrant garden flowers of many colors (*see* Sweet Pea). Garden peas (*Pisum sativum*) have white flowers, and field peas (*Pisum arvense*) have pink or purple blossoms.

Garden peas are eaten freshly cooked, and in the case of the sugar peas the pods are also eaten. More garden peas are canned and frozen than any other vegetable. In one year the United States produced 34 million *cases* of canned peas and 195½ million

THE GARDEN PEA



The seeds, borne in pods (left), are developed from the delicate flower. The butterfly-shaped (*papilionaceus*) blossoms (right) are characteristic of all legumes.

pounds of frozen peas. The vines are used for silage. Wisconsin and Washington are the leaders in acreage devoted to garden peas. The coarser field peas are grown for stock feed. The dried seeds of field peas are ground up with stock-food mashes or sold as "split peas" for making soup.

PEABODY, GEORGE (1795–1869). Though he amassed one of the great fortunes of his time, George Peabody, banker and merchant, is remembered not for his gains but for his gifts. He poured out nearly $9,000,000 in benefactions in his native United States and his adopted country, England, and received honors and gratitude from both nations.

He gave $2,500,000 for model lodginghouses and other charities in London, but his chief philanthropy was in the interest of education. Into the war-torn, impoverished Southern states he sent the $3,500,000 Peabody Fund (1867–69) to help bankrupt cities and towns build and run public schools, to encourage the formation of state school systems, and to assist in the consolidation of rural schools. In 1875, this fund established a normal school in Nashville to fit the southern teachers for their difficult task. This school, now George Peabody College for Teachers, is endowed with what remains of the fund. To Danvers, Mass., the city where Peabody was born, and where he started clerking in a grocery store when 11 years old, he gave a public library and institute. To Baltimore, where his wholesale dry-goods business began the fortune he increased in England, he donated $1,250,000 for Peabody Institute, consisting of a library, an art gallery, and a conservatory of music. Harvard, Yale, Peabody Academy of Science in Salem, Mass., and other educational institutions also shared in his generosity.

He died in London in 1869 and after funeral services in Westminster Abbey, the body was brought for burial to his birthplace.

PEACE MOVEMENT. War has always brought sorrow and suffering to the people of belligerent nations. But its effects have become more terrible with the advance of civilization, and with the increase of population and economic interdependence of nations. Moreover, with the use of modern science in war, the instruments of destruction have become so powerful that a great war has become a world disaster. The appalling costs in lives and property of the first World War, and the heavy economic burdens and severe suffering it left in its wake, led large groups of people in every country to feel that war must be abolished. (*See* World War, First.)

For centuries a few persons in various countries have worked to bring about world peace, but the modern peace movement is distinctly a product of the period since the French Revolution. The first peace society was organized in 1815 in New York City. In 1843 the first international peace congress was held in London. By 1914 there were in the world 160 peace societies, with many branches and an enormous membership.

Serious difficulties confronted the advocates of peace. The causes of war were manifold. Nations with large and growing populations often went to war to gain territory. Others, developing commercially, went to war to gain colonies where they could buy and sell freely. Some nations went to war to free blood kinsmen from foreign rule, to gain a sure outlet to the sea, or to win some disputed strip of territory. Fear undoubtedly played an important part. When one nation saw a neighboring state growing stronger it feared for its own security. It increased its armaments and perhaps sought allies. Suspicion and distrust followed, and then some trivial incident started a great international conflict.

SIGNING THE KELLOGG-BRIAND PEACE TREATY

In 1928–29, representatives of 15 nations assembled in Paris and signed a hopeful agreement to settle future international disputes without resorting to war.

Finally, perhaps the most important single cause of war has been the emphasis which nations placed on their right to do as they pleased. They insisted on their sovereignty and refused to abandon any portion of their independence to the judgment or decision of their peers. They insisted that they were free to fight or to arbitrate, just as they desired. Peace advocates call this condition "international anarchy."

Persons interested in the peace movement have two outstanding objectives in seeking to abolish war: to bring about settlement of international disputes by arbitration; and to bring about limitation and reduction of national armaments. (*See* Arbitration; Hague Peace Conferences.)

Beginning of Organized Effort to Win Peace

An organized international movement in behalf of arbitration did not begin until the close of the 19th century, although nations had voluntarily tried arbitration earlier. In the United States, in 1881, Secretary of State Blaine suggested that delegates of all American republics should meet to consider how to

prevent wars in the Western Hemisphere. The Pan American Union was ultimately organized, and in 1889 a Pan American Conference declared that arbitration constituted the public law of the American nations. Resort to arbitration, however, remained voluntary.

The effort made at the Hague Conferences of 1899 and 1907 to provide for compulsory arbitration failed. Resort to the Permanent Court of International Arbitration was left voluntary.

At the end of the first World War the Paris Peace Conference drafted the Covenant of the League of Nations. This was later signed by about 60 nations, which thereby agreed to submit their differences to some form of mediation or arbitration before they resorted to war. The League of Nations, in turn, established in 1920 the Permanent Court of International Justice for the purpose of settling international disputes which arose over legal questions. (*See* League of Nations.) Many countries, including Germany, France, and England, agreed to accept the jurisdiction of this court as compulsory.

Finally, in 1928–29, most of the great countries signed the Kellogg-Briand Pact. By this they agreed to outlaw war as an instrument of national policy and to seek pacific settlement of international disputes.

Efforts to Reduce Armaments

So far, the movement toward the reduction of national armaments has produced mixed results. The first Hague Conference, called by Czar Nicholas II for the purpose of securing an international agreement to limit armaments, achieved nothing. Early in the present century, Great Britain proposed that she and Germany agree to limit the size of their navies, but Germany was unwilling to do so.

A beginning of the compulsory limitation of armaments was finally made in 1919 at the Paris Peace Conference. Germany, Austria, Hungary, and Bulgaria were compelled to agree to observe the military and naval limitations placed upon them by the peace treaties. These limitations, the Allied statesmen at Paris announced, were the first step toward "the initiation of a general limitation of armaments of all nations." Furthermore, the nations which signed the Covenant of the League of Nations recognized that the maintenance of peace required the reduction of national armaments to the lowest point consistent with national safety. The Council of the League had the responsibility of formulating reduction programs.

After ten years of preparation, a disarmament conference met at Geneva in 1932. There, hatred of war and the general demand for peace were met with each country's fear of invasion or of economic strangulation and insistence on armed security. International suspicions proved stronger than international good will; the conference ended in failure.

Short-Lived Limitation on Navies

Naval limitation had for a time proved more successful. At the Washington Conference called by President Harding, a "naval holiday" was agreed upon in 1922 by Great Britain, the United States, Japan, France, and Italy. In 1930 Great Britain, Japan, and the United States signed another treaty, but Japan did not renew it when it expired in 1936. A treaty signed at the London Conference in 1936 by France, the United States, and Great Britain, and supplementary treaties signed in 1937 by Great Britain, Russia, and Germany did not limit the size of navies, except for Germany. With army expansion already under way, a world-wide naval race began at once.

Not only were attempts to limit armaments unsuccessful, but the League of Nations proved helpless to stem the tide of aggressive nationalism in Germany, Italy, and Japan. Disregarding their obligations under the League Covenant and the Kellogg-Briand Pact, these nations seized the territory of weaker states. Finally, in 1939, Europe was again plunged into war when France and Great Britain took up arms to restrain Germany in its career of conquest (*see* Europe; World War, Second).

Popular Peace Movements

While nations failed in attempts to guarantee peace by pacts and treaties, groups within most nations continued their attempts to promote international good will. Active in the United States were the Carnegie Endowment for International Peace, the World Peace Foundation, the National Council for Prevention of War, and many other organizations, including women's clubs, churches, trade unions, and groups in schools and colleges. These groups emphasized a realistic study of the causes and cures of war, and sought to build up international good will and understanding.

In 1935 the activities of munitions makers in peace and war were widely discussed. Charges were made that many firms had sold arms to both sides in time of war, had blocked disarmament efforts, and had started war scares to help sell their goods.

The second World War added new zeal to the search for a workable peace plan. Before the war ended, 50 nations met at San Francisco and drew up a charter for a new world-peace organization, the United Nations (UN). (*See* United Nations; also section "The Hard Road to Peace," in World War, Second.)

PEACE RIVER. One of Canada's mightiest rivers is the Peace, which drains a fertile farming region in northern Alberta and British Columbia. It is formed by the union of two streams rising in the Rocky Mountain Trench on the west side of the mountains. The Finlay River hurries south for 250 miles. The Parsnip tumbles northward for 145 miles. At the trading post of Finlay Forks they join to form the Peace River.

The new stream then turns abruptly east. It slashes its way into the mountains through a gorge 900 feet deep, from which it issues at Hudson Hope, British Columbia. East of the mountains it crosses Alberta in a great curve to the north and east. Its most important tributary, the Smoky River (245 miles long), enters it from the south near the town of Peace River. At last, 1,054 miles from the head of the Finlay River, it meets a stream flowing out of Lake Athabaska to form the Slave River. Through the Slave its

waters reach Great Slave Lake, and then pass into the Mackenzie River and so to the Arctic Ocean. It is navigable for 527 miles from Hudson Hope to Vermilion Chutes, where it plunges over limestone ledges.

The Peace River Country

The Peace River drains an area of about 74 million acres. East of the mountains an estimated 15 million acres are suitable for grain growing. Little more than one million are as yet under cultivation. This country is a vast plateau that slopes to the northeast from an elevation of 3,000 feet to 900 feet at Vermilion Chutes. The main stream and its tributaries have carved deep gorges that drop abruptly from level rims. At the town of Peace River the stream lies 500 feet below the surface of the plateau.

Much of the plateau is a rolling parkland with open stands of spruce, willow, and poplar and stretches of treeless grass-covered prairie. The best agricultural area is in Alberta, between 55° and 59° N. latitude and from about 114° to 123° W. longitude. Until early in the 20th century this was a wilderness inhabited only by fur traders and missionaries. Few farmers dared to raise crops this far north. Then the fast-ripening Marquis wheat was developed (*see* Wheat). Experiments proved that splendid crops of rye, oats, barley, hay, vegetables, and fruits also would ripen in the brief summer. Raising pure-bred stock and dairying are successful.

The soil is deep and fertile and the climate is warmer than might be expected so far north. Some warmth is contributed by the chinook winds from the Rocky Mountains (*see* Winds). Another factor is the comparatively low altitude of the basin. Northern Alberta is several hundred feet lower than the southern part of the province. Fort Vermilion is only two degrees colder on the average in summer than Cardston, 700 miles to the south. Moreover, crops have the additional advantage of long days of sunshine—as much as 18 hours at midsummer.

Communications and Future Development

The town of Peace River (population, 1951 census, 1,672) is the trading center of the area north of the river. It is connected by railroad with Edmonton. Branch lines extend to Hines Creek in the heart of a rich farming country to the north, and to Dawson Creek, British Columbia. Highways connect the region with Edmonton; with Dawson Creek, the starting point of the Alaska Highway; and with the Hay River country far to the north. A new highway down the Hay Valley to Great Slave Lake will be the most economical route for freight moving between the Peace and Mackenzie River regions.

The greatest need of the country is direct communication by rail and highway to the Pacific coast. The best farm lands have been taken up and are now under cultivation. But the whole country is underlaid with oil and natural gas. In the mountains coal is abundant. Immense water power can be harnessed at Vermilion Chutes and in the gorge at Hudson Hope. Further development of the Peace River country awaits cheaper outlets for its products.

PEACH. Of the 300 varieties of peaches grown in the United States, all are the result of long cultivation. Nowhere has the wild peach been found. Popularly peaches are classed either as "free-stones" or "clings," but there are many gradations. Some varieties are yellow fleshed and some white. They also vary in size, flavor, hardiness, and other qualities. The nectarine is a smooth waxy-skinned variety with a firm and aromatic pulp.

The peach blossoms early, and so exposes its fruit to danger from late frosts. It can best be grown where frosts do not come or where cold springs delay the buds until the danger of frost is past. The chief peach-growing regions in the United States are an eastern belt southward from Connecticut, particularly the Maryland-Delaware peninsula east of Chesapeake Bay and the Alleghenies west of the Great Valley to Georgia; the eastern and southern shores of the Great Lakes; southern Illinois, Missouri, Arkansas, Colorado, Oklahoma, eastern Texas, and the Pacific coast states. California and Georgia lead in value of production.

Commercially the fruit usually ranks next in importance to the apple. Because it is so perishable it scarcely entered into commerce until fast trains and refrigerator cars made it possible to market California peaches in Chicago and New York. Even yet many of the best peaches cannot be marketed except near the place where they are grown. The peach is a luxury rather than a staple, because it is exacting to grow, must be picked as soon as it is ripe but before it is soft, and cannot be kept more than ten days or two weeks. In England and Europe peaches are commonly grown under glass or trained on sunny walls. These peaches are of the highest quality, but the cost is prohibitive for all but the rich.

The peach (*Prunus persica*) belongs to the same genus as the plum, apricot, and cherry. The tree is small, from 10 to 20 feet high, and bears many branches, the fragrant pink blossoms usually appearing before the leaves. The trees are short-lived and are exposed to many diseases. (For illustration in color, *see* Fruits.)

PEACOCK. "As proud as a peacock" is an old saying. The peacock seems to strut with pride as he shows his gorgeous plumage. It combines the metallic shades of bronze, blue, green, and gold, and a crest adorns his head. His chief glory is the long train of brilliantly marked plumes which grow just above the tail feathers. With the quills of the tail, he proudly lifts the train erect and spreads it fanwise to charm the less ornate peahen, the female.

Peafowls belong to the pheasant family. They are natives of the Indian Peninsula and Ceylon, where they are common in a wild state. One cock and three or four hens usually constitute a flock. The crude nest is on the ground or on low branches and contains about six eggs. Male and female of the young birds are feathered alike until about two years old; then the tail coverts of the male begin to develop their brilliant colors.

''JUNO'S BIRD'' WITH THE HUNDRED EYES

The magnificent plumage of the peacock has made him a favorite pet since the days of Alexander the Great. It is said that these birds occasionally reach a great age, but their average span of life seems to be from 20 to 30 years.

Domestic peacocks, now common in almost every country, date from very ancient times. To the ancient Greeks the peacock was known as Juno's bird; according to a well-known myth, the strange eyelike markings of the covert plumes were the hundred eyes of the giant Argus, set there by Juno.

In days of chivalry a special feast-dish was the roast peacock served up garnished with all its gaudy plumage. Solemn oaths were sometimes taken "on the peacock."

Under the Chinese Empire a peacock feather was a distinction awarded to mandarins for public services. These birds have long been the symbol of splendor. The famous peacock throne of the Mogul emperors at Delhi was of unparalleled magnificence, for it had as its background the figure of a peacock with expanded tail wrought all in gold and precious stones.

The Japanese peacock has upper wing coverts of deep lustrous blue, from which the color term "peacock blue" has arisen. The hen of this species is a grizzled white. It is from this variety apparently that the sacred white peacock of India was developed. Scientific name of common peacock, *Pavo cristatus*.

Peanut. The peanut plant is an annual herb of the pea family. Its fruit is a pod and not a true nut. The taste of the raw seed betrays its pea-like character. Only after it has been roasted does it acquire a rich, nutty flavor.

Peanuts are among the most useful products of the soil. Besides roasting the seeds for eating, we get from them peanut butter and peanut oil for cooking. Peanut oil is largely used also as a salad dressing in place of olive oil, which it closely resembles, and for soap making, oleomargarine, packing sardines, etc. For feeding and fattening stock, the vine is almost equal to the best clover hay. Peanut hulls have the food value of coarse hay, and the thin skin that covers the nut itself can be used in the place of wheat bran in cattle fodder. Finally, the roots of the plant, if left in the soil, enrich it with invaluable nitrogen products (*see* Nitrogen). There is thus very little about the peanut plant that cannot be used in some way or other.

The food value of the nuts, long eaten merely as a relish, is only beginning to be appreciated. They contain "per pound more protein than a pound of sirloin steak, plus more carbohydrate than a pound of potatoes, plus one-third as much fat as a pound of butter—an amazing total." Unlike dairy products and meat, the nuts keep without deterioration for years. The United States Department of Agriculture urges the use of peanut meal as a meat substitute, in soups, and mixed with other meals and flours in griddle cakes, muffins, etc.

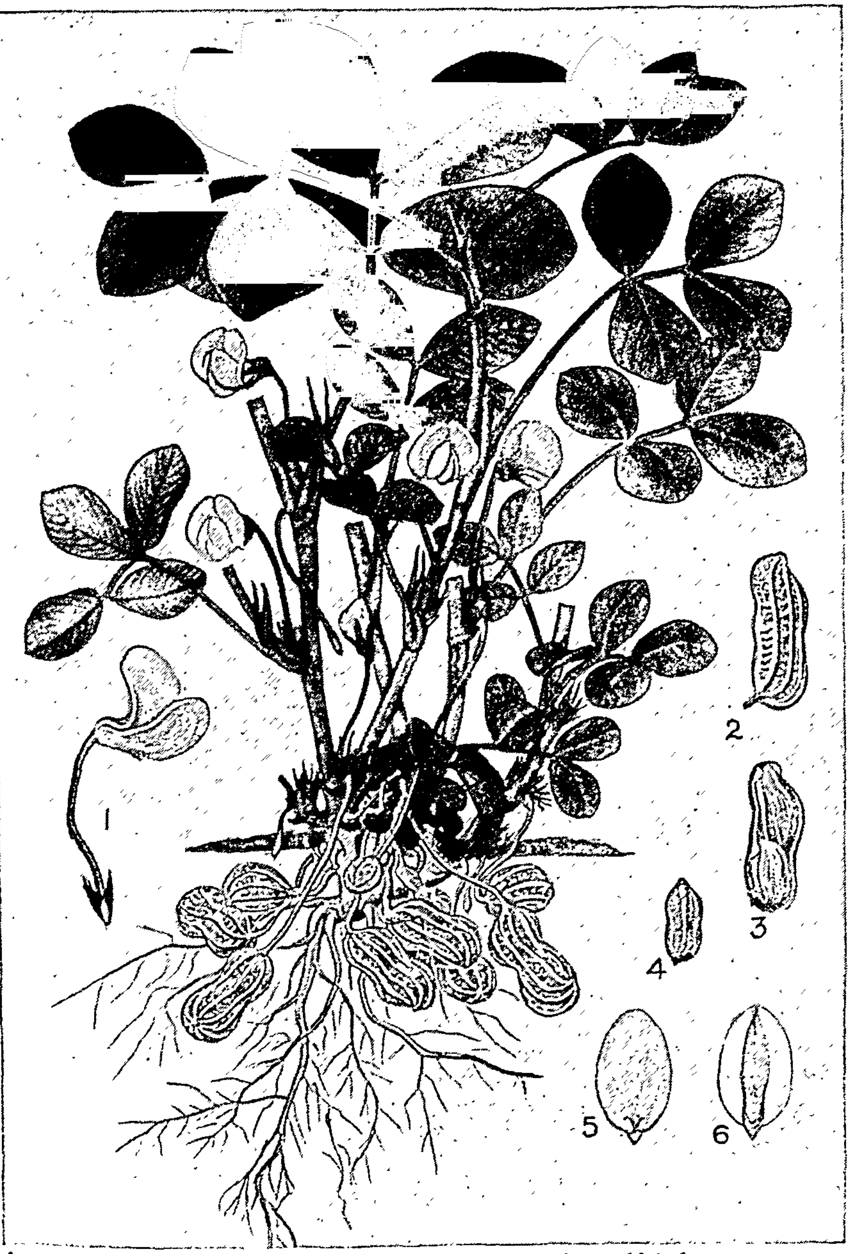
The peanut plant is remarkable for the way it produces its fruit. After the flowers have fallen, the flower stalks bend down and push into the ground, where the pods or "nuts" develop. From this it is called the groundnut, earthnut, and ground pea or goober in various localities.

The plant (*Arachis hypogaea*) grows from the Brazilian tropics, where it originated, to Virginia and Argentina, and from Senegal to China. Because it can endure long drought and grow when rain comes it is of especial value in semi-arid regions, as the southwest of the United States. The yield per acre is from 34 to 60 bushels of nuts in the shell, with a ton to a ton and a half of good hay. If an acre of land can produce 20 bushels of wheat, 40 bushels of oats, or 40 bushels of peanuts, it will yield 154 pounds of digestible protein in the wheat, 149 in the oats, or 186 in the peanuts, and 24 pounds of fat in the wheat, 61 pounds in the oats, and 300 pounds in the peanuts.

Although most of the peanut crop in the United States is used as human food, it has been found very profitable to "sell peanuts as pork." Under this plan, the tops of the plants are cut and gathered for hay, then hogs are turned into the field, where they root out the nuts and eat them, gaining weight rapidly with this diet.

Since about the time of the Civil War the peanut has been grown in the Southern states in increasing quantities. In many cases, especially in the boll-weevil district, it is more profitable than cotton. The American peanut is larger and finer-flavored than any other, but contains less oil than the African nut. Two types chiefly are grown in the United States, the large-podded white or red peanut, with two, three, or even four kernels; and the Spanish or African small-podded peanut which produces small roundish peanuts of milder flavor. The crop in the United States averages about 800,000,000 pounds. China is the chief foreign source of supply.

HOW FLOWERS TURN INTO PEANUTS



A peanut plant in bloom, showing also (1) the flower stalk from which the pod develops; (2) a whole pod; (3) a pod opened to show the seeds; (4) a seed; (5) a seed with skin removed; (6) a seed split.

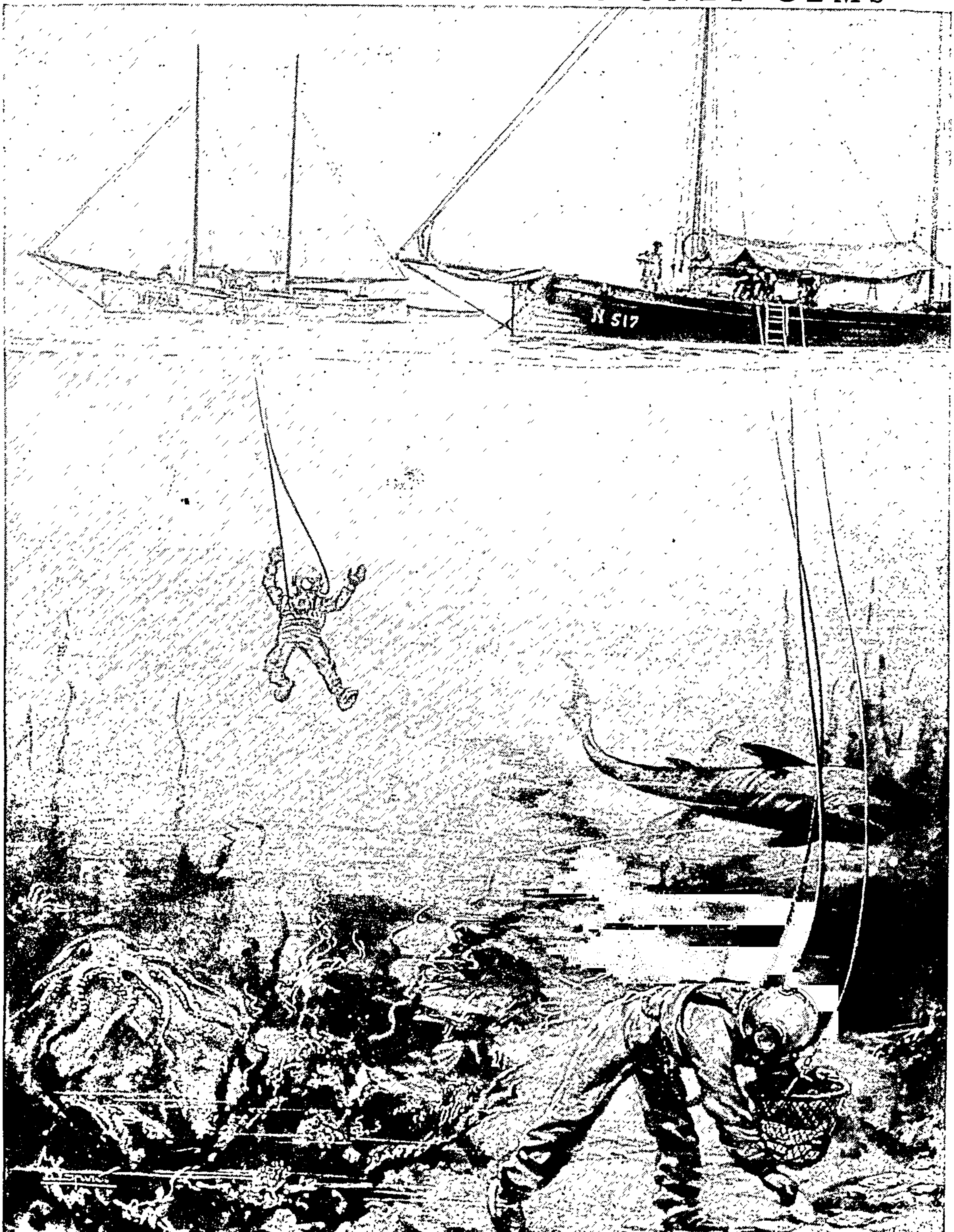
PEAR. The worst fault of this delicious fruit is the hospitality extended by the tree to various insect pests. The inedible Chinese sand pear is hardier, is immune to the pear blight, and has a wider range of cultivation than the tender, juicy European varieties. Hybrids between the two kinds have been produced which combine many of the desirable qualities of both, and good results are also obtained by grafting superior fruited varieties on the hardy rootstock of oriental pear seedlings.

The pear tree was probably a native of western Asia, but it is now grown in all temperate climates, with France and the United States as the principal producing countries. Among American orchard fruits pears rank high in market value. From New England to the Great Lakes, in California, and also in portions of Oregon and Washington are the principal regions of cultivation in America. In England the pear is trained to grow fan-wise on walls exposed to the southern sun, for the climate there is too cool for the fruit to ripen otherwise. The popular Bartlett pear, widely grown in America, is a variety brought from Europe, where it is known as "bon-chrétien." The small Seckel pear excels in flavor and quality of its fruit. The large Kieffer pear, excellent when baked but almost uneatable raw, is one of the best of the oriental hybrids.

Pears are usually picked while they are still hard and imperfectly colored, for if they are left on the tree they become tasteless and gritty; after picking they are stored in a cool place to mellow. Pears are popular as a dessert fruit, and are extensively canned, preserved, spiced, and pickled.

The cultivated pear tree is free from thorns, but on the young wild pear tree the ends of the branches form sharp spines guarding the fruit of the tree. Many of the disease and insect pests which attack the pear are the same as those which attack the apple, but there is a distinct pear-leaf blight, which is best remedied by spraying with Bordeaux mixture. Like so many of our orchard fruits, the pear (*Pyrus communis*) belongs to the rose family.

SNATCHING NEPTUNE'S ONLY GEMS



The pearl is the only precious gem which is obtained from the sea. Unlike mineral gems, such as the diamond, the pearl needs no cutting to improve it. Except for a little polishing it is a finished gem when it is taken from the oyster. The finest pearls come from the Far East, many of them gathered by Japanese or Malay divers who simply plunge in, holding a heavy stone which helps to pull them to the bottom. Where the pearl-gathering industry is better organized, the men are equipped with diving suits, as you see here. Divers, particularly the naked natives, are occasionally attacked by sharks, or seized by octopi and held down until they drown.

PEARLS. Most shell-covered water animals or mollusks line their shells with a secretion which produces a smooth, whitish shimmering inner surface called nacre or mother-of-pearl, much used for buttons, knife and fork handles, inlay work, etc. This lining is to protect the delicate bodies of the animals from contact with the otherwise rough covering. Doubtless you have often admired the enamel-like glossiness of the inside of a shell. The secretion is deposited in a series of milky, satiny, transparent films which, hardening, produce a beautiful play of colors.

A pearl is really a calcareous (limestone) deposit of a sick mollusk. Often a grain of sand, a minute marine creature, or other foreign substance finds its way into the shell and irritates the animal. Then the animal, unable to remove it, covers it with successive layers of this membranous substance, and thus pearls are formed. Sometimes the animal is attacked by a parasite boring through the shell from the outside. It repairs the damage by depositing its secretion over the hole in the form of a half sphere, thus forming a blister pearl.

Genuine precious pearls and the most valuable mother-of-pearl are produced by various species of pearl oysters of the genus *Meleagrina*, although inferior pearls are sometimes found in the common edible oyster. Since the pearl naturally partakes of the character of the shell, it is useless to look for pearls of value in the dull opaque shell of the ordinary oyster. Pearl oysters lie on the hard sea bottom at a depth of from 50 to 150 feet. They are collected by divers working in crews. They may be opened on board ship or they may be gathered in boatloads and taken to the beach, where they are spread out to decompose. Afterward they are washed and the pearls are removed carefully with special pincers or hammers. (*See* Diving; Oysters.)

OPENING THE SHELLS TO LOOK FOR PEARLS

What a fascinating task this must be! Who knows but the very next shell may contain a pearl worth a fortune? Below is one of the pearl oysters containing a large "stone." Pearls must be handled with care. Hot water destroys their luster; for this reason pearl rings should always be taken off before washing one's hands. Pearls seem to require the touch of life to keep them brilliant; they have been known to get "sick" and "die" when not worn for a long time.

Fresh-water pearls are found in a family of fresh-water mussels. Some of the most valuable seed pearls (the smallest pearls) are found in mussels in the rivers of Scotland, Ireland, Germany, Russia, China, etc. Half-pearls and baroque pearls have been produced by the Orientals since the 13th century by inserting some foreign particle into the lining of a river mussel and allowing it to be coated with nacre. In 1912 the first cultured pearls of perfectly spherical shape were produced by Japanese, but even these can be distinguished from the natural product by the use of X-rays. The best imitation pearls are made of glass beads coated with gelatin and the scales of the bleak, a fish found in European rivers.

The Persian Gulf yields the best grade of pearls Among other important pearl fisheries are those in the Sulu Archipelago, off the Australian coast, in the Aru Islands, the Pearl Islands, in the Bay of Panama, in the Red Sea, off the Philippines and Burma, and in Ceylon. The largest pearl fishery in America is that of Lower California, from which come the largest and finest black pearls on the market. The largest pearl known is two inches long and four around, and weighs about three ounces.

PEARY, ROBERT EDWIN (1856–1920). "Stars and Stripes nailed to the North Pole.—PEARY." It was on the afternoon of Sept. 6, 1909, that this dramatic message, flashed by cable and telegraph, thrilled the world. So the long fight had been won at last—the fight of three centuries, in which so many men of different nationalities had given their lives, and in which so many deeds of daring and fortitude had been performed.

Peary had actually found the pole on April 6, 1909, just five months before his message was received. He was the only white man of his expedition to reach it. With him on the sledging party, in the last dash, were his negro follower Matthew A. Henson and four Eskimos. For 53 days they and their dog teams marched across the polar ice-pack, from the last point of land to the pole, and back, a distance of 950 miles. The way was beset with many dangers, yet courage and the wisdom born of long Arctic experience conquered them all.

HE NAILED THE STARS AND STRIPES TO THE NORTH POLE

Rear Admiral Robert E. Peary reached the North Pole on April 6, 1909, after seven previous efforts. The points farthest north reached by Dr. Nansen, the Duke of Abruzzi, and Peary himself on his previous trip in 1906 are shown on the globe. Peary is shown here in the garb he wore when he made his historic discovery on April 6, 1909.

It was no accident that the long-coveted prize should have been won by Peary. For 18 years he had hoped and worked, returning time and again to the polar regions, always learning from his failures, always paving the way for the final victory.

Born in Pennsylvania and educated at Bowdoin College (in Maine), at 25 he had entered the United States navy, after a civil engineer's training, and in 1887–88 he was chief engineer of the Nicaraguan Canal survey. The year before that, at the age of 30, he had made his first trip to the Arctic regions, visiting the Greenland ice cap. From that day onward the lure of the North was in his blood, the great white spaces haunted him in dreams, and he could never again live at ease. His wife shared his ambition, and spent several winters with him in the Far North, where their little daughter was born. The child was called the "Snow Baby" by the Eskimos, because her skin was so white.

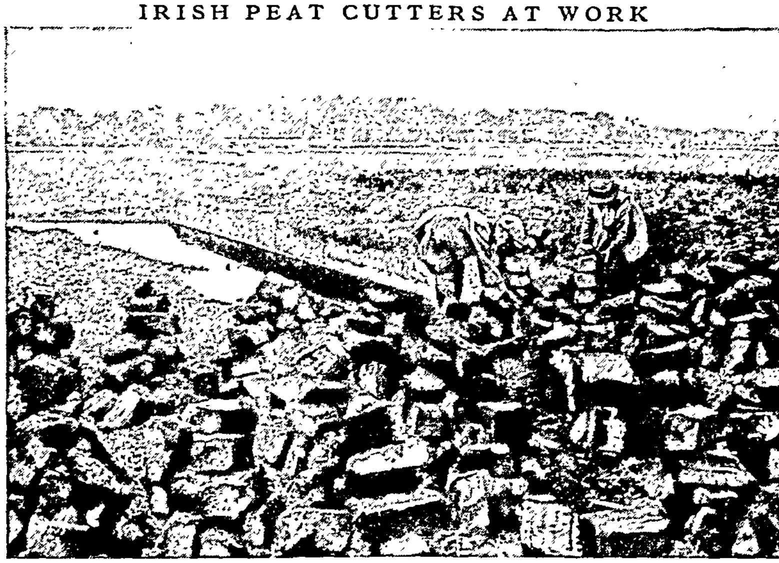
The expedition which finally reached the pole was the eighth which Peary had made into the Arctic regions. They had all been of much scientific value. Peary had explored Greenland, crossing its northeastern corner in one of the most remarkable sledge trips ever made, and had proved it to be an island (1891–92); he had brought home the great Cape York meteorites, the largest then known; he had obtained a vast mass of valuable information in different fields, and he had several times attempted to get to the pole itself, without success. On one of these expeditions he froze his feet so severely that he lost his toes.

For his final success he received great honors from nearly all the important nations, and the United States Congress gave him a vote of thanks and raised him to the rank of rear admiral. A few skeptics questioned his claims, but the scientific world now almost unanimously accepts him as the discoverer of the North Pole.

Peat. The making of peat is the first step in the making of coal in Nature's great factory. Peat is a dark brown or blackish mass of partly decayed vegetation formed in marshes, swamps, and bogs. All sorts of marsh plants, from mosses to trees, enter into its composition. It is much used for fuel in northern and northwestern Europe. Peat is found chiefly in rather high latitudes, mostly in the Northern Hemisphere. This is because most marshes and bogs are in the high latitudes of the Northern Hemisphere, and not because, according to a common idea, vegetable matter decays too rapidly to form peat in low latitudes. Dismal Swamp, in Virginia, is a fine example of a peat bog. Most peat bogs are within the area that was once glaciated, because that is where most undrained depressions appropriate for bogs are found. A common plant in many peat bogs, which helps to form peat, is a moss known as sphagnum moss or bog moss (*see* Moss). Peat deposits grow from 2 to 4 inches a year.

The manner of peat formation is as follows: the various marsh plants continue to grow above and decay beneath. The decaying matter below is in water and forms a heavy mass of water-soaked tissue which, as time goes on, becomes thicker and thicker and more deeply buried beneath the new growth. Under increasing weight above, it is pressed into the rather spongy dark-colored substance known as peat. If the peat is buried deeply beneath sediments, such as mud, it is compressed much more, and at the same time it is cut off from contact with the air. Chemical changes take place in it, and in the course of long ages—millions of years—it is transformed into a form of coal.

IRISH PEAT CUTTERS AT WORK



The cutters use a spade, and pile up the blocks to dry. A peat bog is moist and spongy to walk on.

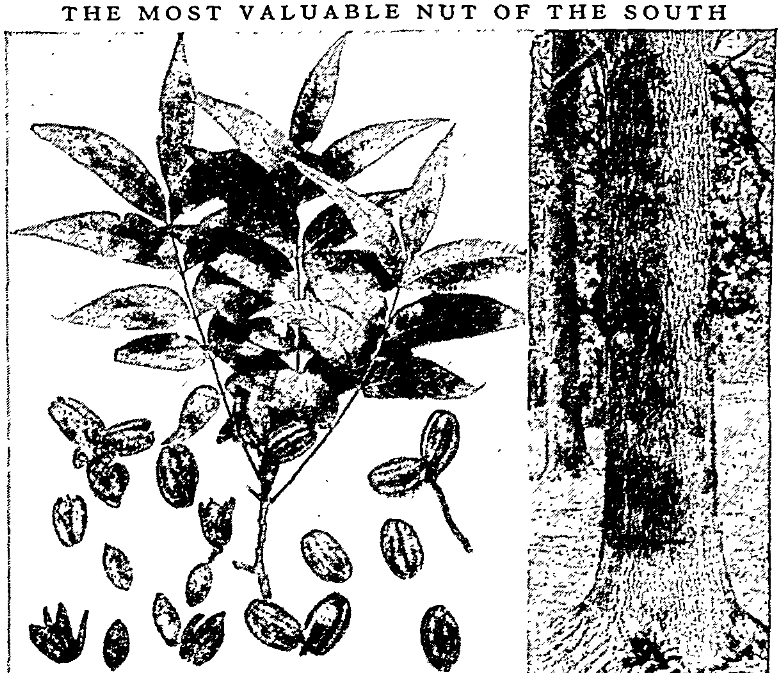
Peat bogs tend to preserve vegetable or animal remains which become buried in them. The leaves of plants which compose it are in some cases so well preserved that it is possible for botanists to determine the species to which they belonged. In some instances, human and animal bodies have been found in peat bogs in a good state of preservation, even after the lapse of several centuries, as shown by the fact that with them are weapons, tools, and armor of the men of the distant past.

Peat is cut out in blocks by the peasants in Ireland and other countries and piled in the sun to dry. It burns slowly, gives a dense black smoke, and leaves much ash. Peat compressed into compact bricks forms a much better fuel than in its natural state, but it has come into general use only where the supply of other fuels is meager. Peat is also used, though not extensively, for the making of paper, for fertilizing soils and for stable litter.

PECAN'. The pecan, because of its thin shell and fine-flavored kernel, has long been a prime favorite in America, and in the past few years has become the most valuable commercial nut in the United States. The tree (*Carya pecan*) is a member of the hickory genus and is found native in the United States as far north as Illinois and in Mexico.

While the great bulk of the market supply comes from native trees along river bottoms, plantations of considerable extent have been set out in Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Florida, and in central and northern California, and the demand still far exceeds the supply. The pecan will thrive as far south as the Gulf of Mexico, and as far north as central New York, although in the higher latitude crops do not pay cultivation. It is especially well adapted to the sections drained by the Mississippi as far north as central Illinois and central Indiana, and to "two-story farming," which means planting the trees thinly scattered in fields where quick-growing crops like cowpeas, sorghum, or clover are raised for pigs to harvest.

THE MOST VALUABLE NUT OF THE SOUTH



In sections where they can be raised, pecan trees yield a greater revenue than any other tree.

The trees begin to bear a few nuts the third year, but not until the tenth or twelfth year can commercially valuable crops be expected. An annual yield of 50 to 100 pounds per tree is satisfactory and the

yield may be larger, depending on the size and age of the tree. Under favorable conditions the trees will live to a great age, and there are, living and bearing in Texas and other Southern states, trees that are said to be 300 years old. There are about 100 different varieties, many being cultivated improvements of the native tree. The nut grows in a husk or outer shell very much like a hickory nut and falls from the opened husk when ripe.

The pecan meats of commerce are shelled by machinery. The nuts are fed down from a hopper, seized singly between clamps at either end, and cracked. The rapid fingers of girls and women pick out the meats and sort them. Into one barrel go the perfect meats, into another the broken ones.

PEC'CARY. This piglike animal of the New World is sometimes called the muskhog, from the presence of a large gland on the rump which emits a powerful odor. There are two species. The more northern or collared peccary occurs as far north as Red River in Arkansas, and ranges south to Rio Negro in Argentina. This species is about three feet long, occurs singly or in small herds of eight or ten, and is comparatively harmless. The white-lipped peccary is about 40 inches long, and like the collared peccary is covered with thick bristly hair; its range is between Paraguay and British Honduras. White-lipped peccaries occur in herds of 50 to 100 or more, and when attacked fight fiercely with their small but sharp tusks. Both kinds live on roots, fruits, worms, and the like. In cultivated districts they do some damage to crops, but, on the other hand, are of service to the farmer in destroying reptiles. Scientific name of collared peccary, *Dicotyles tajaçu* or *torquatus;* of white-lipped peccary, *Dicotyles labiatus.*

PEEL, SIR ROBERT (1788–1850). "Here comes a bobby," shouts the mischievous London street urchin when he sees a policeman approaching, and a lad in Dublin in a similar situation may cry out, "There's a peeler." Both of these nicknames for the blue-coated officer of the law come from the name of Sir Robert Peel, the British statesman who first organized the London police force (1829) and also the Irish constabulary.

This man, the son of a rich cotton manufacturer, a graduate of Oxford University (1808) with the highest honors attainable, and twice prime minister of Great Britain, was the author of many epoch-making measures. And yet he entered Parliament in 1809, at the age of 21, as a Tory who believed in the established order. This was the time when England, in arms against Napoleon, was opposed to all change because of fear of the radicalism of the French Revolution. After the close of the war this feeling wore away, and the march of political progress went on.

When Peel was in the Duke of Wellington's cabinet, in 1829, he proposed and carried through the Catholic Emancipation Bill, giving Catholics the right to become members of Parliament and hold other offices (*see* O'Connell, Daniel). This was a complete reversal of the former positions of Peel and Wellington and it almost split the Tory party; but Peel and Wellington believed that it was the only measure that could preserve peace in Ireland.

Peel while out of office opposed with all his might the great Parliamentary Reform Bill of 1832 (*see* Russell, John). In the years of Whig administration that followed he devoted his energies as a member of Parliament to strengthening the Conservative party, as the Tories were now beginning to be called. As the recognized head of that party, he was prime minister in 1834–35; but as the Whigs still had a majority in the House of Commons, he soon resigned.

By legislation restoring specie payments (1823) and other measures, Peel had already won the reputation of a financier and statesman of the first rank. His great opportunity for constructive reform came in his second ministry (1841–46). Tariff duties were lowered, laws limiting the employment of women and children in mills were passed, foreign relations with France and the United States were improved, and a new charter was passed for the Bank of England.

Then came the crowning act of Peel's career, in 1846. Because of a potato famine in 1845 thousands in Ireland faced starvation. For a number of years an Anti-Corn Law League in England had been agitating to secure the repeal of the import duties on grain, in order to cheapen food; but the Conservative party, largely made up of landlords, had opposed the measure. Although Peel was a "free trader" on all else, on grain he had hitherto followed his party. But now "famine forced his hand," and with the aid of the Whigs he repealed the Corn Laws, as a relief measure for Ireland. Many of Peel's followers deserted him, and he was soon defeated on a measure in Parliament and forced to resign as prime minister. Though he had "lost a party, he had won a nation," and for the remaining four years of his life the liberal measures passed by the Whigs were largely due to his support. When he died, from the effects of a fall from his horse a few years later, the common people felt that they had lost a friend who had given them "bread unleavened with injustice," and all England recognized the loss of a great statesman.

PEGASUS (*pĕg'ȧ-sŭs*). When Medusa was slain by Perseus, there sprang from her body, according to the old Greek story, the winged horse Pegasus (*see* Perseus). Bellerophon caught and tamed Pegasus by means of a golden bridle which the goddess Athena (Minerva) presented to him, and mounted on his back was able to slay the Chimera, a fire-breathing monster, part lion, part goat, and part dragon.

Pegasus remained the faithful companion of Bellerophon, carrying him wherever he chose. At last Bellerophon impiously attempted to mount up to heaven, but Zeus (Jupiter) sent a gadfly which stung Pegasus so that he threw Bellerophon, who fell to the earth, lame and blind. Pegasus, however, was placed among the stars.

It was said that the sacred spring Hippocrene on Helicon, the mountain of the Muses, was opened up by a blow from Pegasus' hoof. For this gift the winged steed was greatly honored by the Muses. Because of his association with the Muses, Pegasus has come to be regarded as the poets' steed, who bears them aloft into the realms of fancy.

PEKING (PEIPING), CHINA. The name *Peking* means "northern capital." And time and again, through nine centuries, Peking has been the capital of all China. But when Nationalist forces seized it in 1928, they ousted the nominal president of China and changed the city's name to *Peiping.* That means "northern peace." The Nationalists then made Nanking the capital. In 1937 the Japanese took Peking and held it until 1945. Then after the Communists overwhelmed China in 1949, they changed the city's name back to Peking and made it the national capital.

Peking is a city of crowds and huge walls of mud and dust, of incredible filth intermingled with a strange and ancient oriental beauty, of hovels and shining temples and palaces. As people walk down a narrow squalid street, groping their way through never-ending streams of chattering crowds, they hear shrill cries of warning and squeeze against doorways while a caravan of camels lumbers by. They have come perhaps from far-away Mongolia, across the Gobi Desert, through the Great Wall, bringing to Peking rich wares from the north. They force a path through the tangle of two-wheeled hooded horse-drawn carts and man-drawn jinrikishas. A lean barelegged jinrikisha puller protests, hurling a volley of insults at the camel drivers, while a Chinese official sitting in the vehicle looks on unmoved, his arms stolidly folded.

To get a good view of Peking one mounts the famous wall of the Tatar City, as the northern portion of the former capital is called. This wall is 42 feet high and nearly 40 feet broad at the top, and marked off at intervals by lofty and imposing watch-towers. It is a relic of the Tatar invasions of the 10th and 12th centuries, and incloses the former Imperial City, as well as the famous Forbidden City where the emperor used to live, and which only a few foreigners had ever penetrated until the Boxer rebellion brought European and American troops to Peking in 1900.

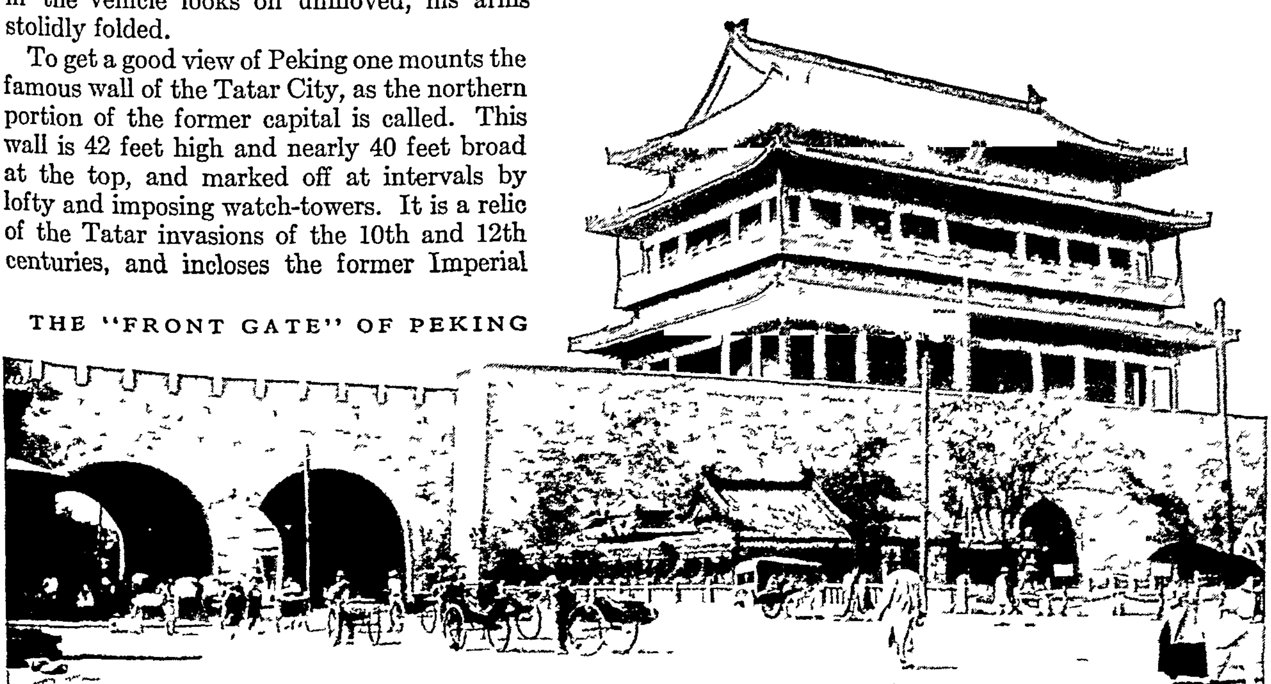
South of the "Tatar City" is the so-called Chinese City, enclosed by a 30-foot wall, built in 1543. Thus Peking is a double city, with an area of about 25 square miles and a circumference of 30 miles.

From the top of the Tatar wall one sees innumerable Buddhist temples and old palaces peering out from groves of trees, in contrast to the low huddled houses in the more crowded quarters. The red, blue, or yellow tiles of the gracefully curving temple roofs put gorgeous splashes of color into the scene, while a touch of silver from some lotus pond flashes in the background.

A better view of the Forbidden City can be obtained from Prospect Hill, an artificial mound 150 feet high topped by five summits, on each of which stands a temple. Near by are the crumbling palaces and homes which housed the former emperors and their courts. Gracefully arched bridges of white marble lead over the flower-bordered pools which dot the parks, and everywhere the oriental love of delicate decorative details is manifest. One of the old imperial buildings housed a priceless collection of royal treasures, which were removed to the interior of the country when the Japanese seized Peking.

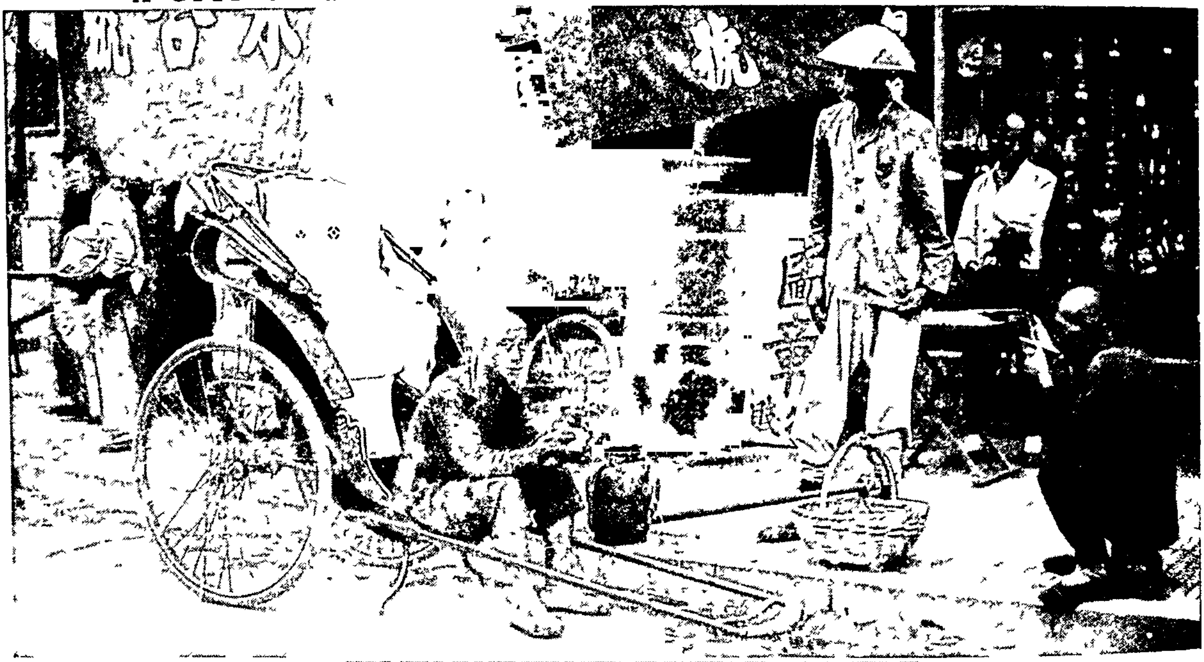
In the Chinese City, the most notable building is the Temple of Heaven, with its huge altar, where for five centuries the emperors prayed to Shang-Ti, the Supreme Being or God of Heaven. But more interesting than ancient palaces or temples is a trip through

THE "FRONT GATE" OF PEKING



The famous Chien Men or "Front Gate" pierces the great wall of the Tatar City on the south side. You can see from this picture the amazing thickness of this wall. The structure rising above the wall on the right is one of the "towers" which formerly housed the imperial troops guarding the wall.

A CITY OF TEEMING STREETS AND TOWERING TEMPLES



The top picture shows a typical scene in the business section of Peking. Two workers, one a rickshaw man, find respite from toil by pausing for lunch right on the curbing of one of the busiest streets. At the bottom we see the altar of prayer for good harvests, a part of the Temple of Heaven. The roof is made of porcelain tiles of an exquisite deep blue color.

the crowded bazaars. Furs of tiger, leopard, and wild cat are offered for sale, along with costly embroideries and brocades, jade and porcelain wares, strange candies and sugared fruits—all mingled in great confusion.

Within the Tatar City is the Legation Quarter. Here are the foreign legations, banks, clubs, and business houses. Before the Communist régime it was a self-sustaining city, with its own government, police, and public utilities.

Peking's environs also are full of interest. Eight miles away is the famous summer palace of the former imperial family. The grounds are a fairyland of artificial mountains over which wind intricate pathways and miniature streams and waterfalls. A short railway journey will take the traveler to the Nankow Pass in the Great Wall, through which passes most of the trade between Mongolia and China. In a picturesque, hill-encircled valley, two hours' journey by donkey from Nankow, are the Ming tombs. An avenue three miles in length leading to this ancient burial place of the emperors of the Ming Dynasty is lined with large images carved from solid blocks of marble, representing lions, elephants, camels, horses, military officials, and sages.

For centuries Peking has been the cultural center of China. The nation's great scholars attended its universities and won here the coveted degrees which were the key to high public office. When the Japanese conquered the city, the five national universities moved with their faculties and students into the interior, leaving behind them most of their books and laboratory equipment.

Although Peking is the center of a large Chinese trade it is not industrially important. Most of its commerce is carried on by railway through the great seaport of Tientsin (see Tientsin). Following the Japanese conquest, the city was the focal point of the puppet governments in occupied China. After Japan surrendered in 1945 (see World War, Second), Peking was restored to the Chinese. Population (1953 est.), 2,768,149.

PELICAN. Nature must have been in a jovial mood when she fashioned the queer-looking pelican. She kinked a vertebra in the bird's neck, so that the pelican can never raise its face; she gave it a long, weak beak, more than a foot long; then she fastened

HOW THE PELICAN DOES ITS FISHING

The large picture is a portrait of a brown pelican. Its beak pouch can hold two quarts. Notice the metal band put on its left leg by a bird student for identification. Now watch it fishing. First, it dives straight down. Then it hits the water cleanly, its wings held straight back. Finally, after seizing and eating the fish, the pelican rises to scout for more prey. It may soar for hours at a time. At the lower right, two pelicans spar for possession of a fish.

to the lower mandible a pouch of skin that stretches to a depth of six inches. Some species of pelicans use this pouch as a net in their fisherman trade, scooping fish into it through their wide open mouths.

These solemn-looking birds are fond of company, flocking together in great colonies to bring up their families, and they usually set out in groups on fishing trips. One might wonder what enjoyment the pelican derives from this close association with his fellows, since he is a silent creature, emitting no sound excepting an occasional grunt.

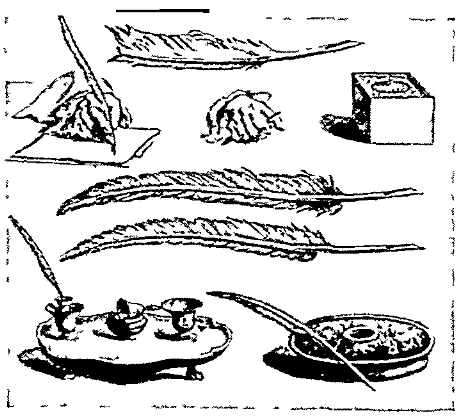
On land, pelicans are awkward birds, but in the air they perform graceful and magnificent group flights. They swim very well. Their bodies, built with numerous air sacs, are buoyant as cork, and their large webbed feet make strong paddles.

WRITING WITH THE STYLUS

This chalk relief of 1350 B.C. shows sharp-eyed Egyptian bookkeepers deftly using the stylus to inscribe records on wax-coated tablets of wood.

Baby pelicans are naked and blind at birth and require parental care until they are eight weeks old. They are fed on predigested fish; that is, the parent regurgitates the food for the young from its crop into its pouch. To see the parents feeding these wabbling and ugly babies is a funny sight. The old bird opens its great beak, and the little pelican sticks his head in and helps himself to the fish soup. As the young grow larger they go farther and farther in for their meals until their heads and necks are pushed far within the parents' capacious maws.

PREPARING REEDS AND QUILLS TO WRITE



To skilled hands and reed pens (upper left), we owe priceless manuscripts. At the upper right we see how knives sharpened quill pens and became known as "penknives." At the lower right are the quill pens and the many accessories that graced a writing desk in the 18th century.

There are eleven species of pelicans in the temperate and tropical regions of the world, three species inhabiting America. The larger pelicans measure about five feet in length and have a wing span of nine feet. Except the spotted-billed pelican of Asia, which nests in trees, these birds place their one to three coarse-shelled eggs in crude nests built on low bushes or on the ground.

Western North America is the home of the white pelican, which frequents inland fresh-water lakes as far north as Canada. During the breeding season the male of this species has a peculiar bony crest on top of the upper mandible, which drops off later like the antlers of a deer. The easternmost breeding area of this bird is Yellowstone Lake, Wyoming. Formerly they nested as far east as the Mississippi River, but the gregarious habits and showy coloring of this great pelican proved so great a temptation for the hunter that they were driven to more secluded regions. The common, or roseate, pelican of Europe is believed to be a species closely related to the American white pelican, which it resembles in habits and plumage.

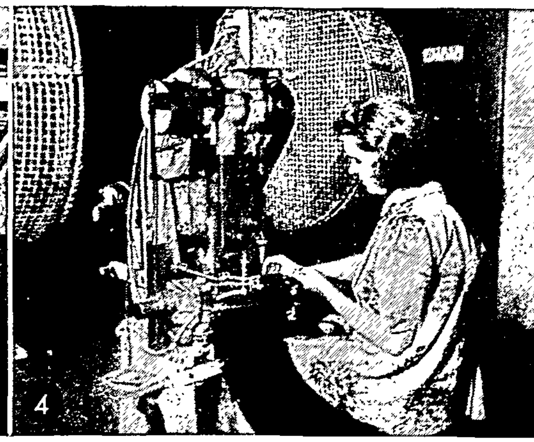
The brown pelican is found in Florida and along the Gulf coast of the United States and on the Atlantic coast of Central and South America as far as Brazil. Thousands of these birds nest every year on Pelican Island in Indian River, Fla., which is a government reservation for them. It is the unofficial state bird of Louisiana. The California brown pelican inhabits the western coast of the United States and Mexico. (For picture in color, *see* Birds.)

Pelicans belong to the family *Pelecanidae* (order *Steganopodes*). Scientific name of white pelican, *Pelecanus erythrorhyncus;* of brown pelican, *P. occidentalis;* of California brown pelican, *P. californicus.*

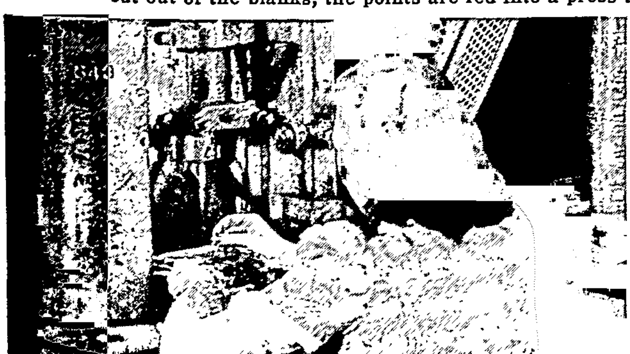
PEN. When an ancient Roman wrote a letter he inscribed the words on the wax-coated surface of thin boards or tablets with a pointed bone or metal stylus. For books and other writings intended to be preserved, the scribe wrote on sheets of papyrus or parchment with a split reed pen (*calamus*). The reed pen, which is used to this day in Iran and some other Eastern countries, was the ordinary writing implement in Europe until the introduction of paper made finer pens necessary and quill pens came into use. They were employed so generally that the quill came to be an accepted symbol of the writing profession. These quills were taken from the wing of a large bird, usually a goose or swan; and quill pens are still occasionally used. The quill gives us our word "pen" (from the Latin *penna*, "feather") and the term "penknife," which is still used to mean a pocketknife, is a reminder of earlier

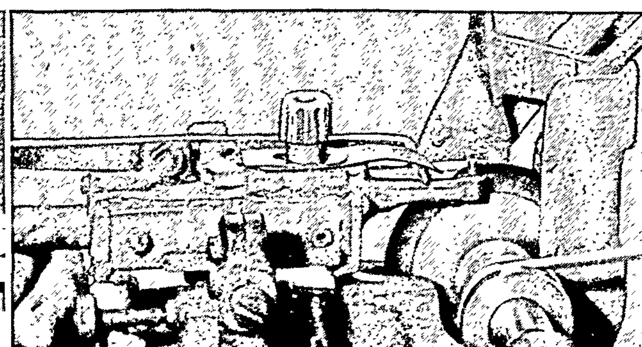
MAKING GOLD POINTS FOR FOUNTAIN PENS

1. From an ingot of 14-karat gold is rolled a long ribbon-like strip hardly more than one-fiftieth of an inch thick. 2. The strip is guided through a blanking machine that automatically presses out flat blanks from which the points are to be made.

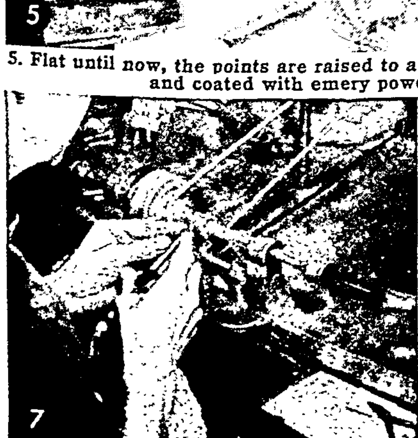


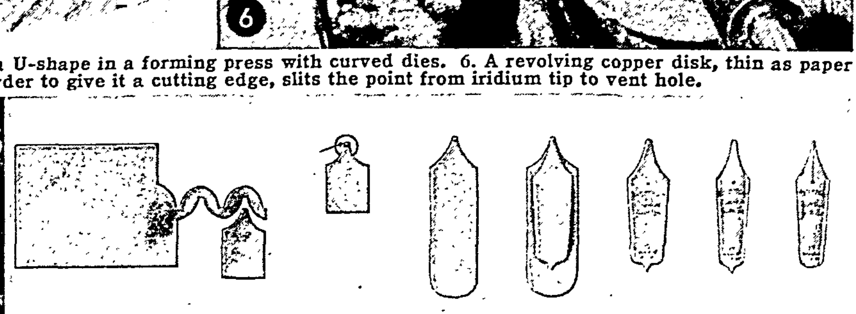
3. Each blank is hand-tipped with a granule of iridium, and the gold is fused over this with blow torches. 4. After being rolled and cut out of the blanks, the points are fed into a press that punches the vent hole and imprints the trademark.





5. Flat until now, the points are raised to a U-shape in a forming press with curved dies. 6. A revolving copper disk, thin as paper and coated with emery powder to give it a cutting edge, slits the point from iridium tip to vent hole.





7. A form grinder, surfaced with oil and powdered emery, fits the point for smooth writing by shaping its iridium tip into a ball and trimming the shoulders. 8. Here we review the different steps which have transformed a strip of gold into a sensitive writing instrument that can give long years of service.

days when people used the pocketknife to mend their quill pen points.

Experiments were made in the manufacture of steel pens late in the 18th century. A penmaker named Wise produced steel pens in 1803, but they were not satisfactory. Joseph Gillot of England made a successful steel pen in 1820. John Mitchell used machinery in making pens in 1822. These so-called "barrel pens" were tubular and had nib and barrel in one piece. About 1828 James Perry introduced "slip pens," somewhat like those of today, for use with holders. The manufacture of steel pens in the United States began in 1858. Today the chief American factories are at Camden, N. J., and Philadelphia, Pa. England's pen industries are centered in Birmingham.

The pens are made from sheets of fine steel, about 1/40 of an inch thick—about three times as thick as the finished pen. The strips are heated, then slowly cooled to soften the metal. Rollers stretch the strips until they are the required thinness. Then machines stamp out the pointed blanks. A central hole is punched to hold the ink, and the flat blanks are curved into the familiar pen shape. To make the points tough and springy, they are again heated, dropped into cool oil, and tempered over fire.

Gold pens, used chiefly in fountain pens, are tipped with iridium, osmiridium, or an alloy of platinum and iridium to protect the soft gold from wear. Fountain pens have a reservoir of ink in the barrel. This feeds the point automatically when the pen is pressed down in writing. A smooth flow of ink was first achieved by L. E. Waterman in 1884. The modern fountain pen has five basic parts—a nib; a hard rubber or plastic barrel containing the ink; a feed which regulates the flow of ink from barrel to point; a section which holds the feed and nib; and a cap to cover the pen when it is not in use. Some elaborate pens have as many as 21 different parts. Even the simplest pens require more than 200 separate manufacturing processes before they are complete. Fountain pens are filled with a special filler or automatically by drawing ink into the barrel through the point. A "snorkel" type of pen has an extensible tube through which ink is drawn.

A *ball-point* pen that writes under water or on cloth or plastic as well as on paper was invented by Ladislas Biro. For a point, the pen has a minute steel ball that rolls ink onto paper instead of inscribing it. A quick-drying viscous ink is used

PENCIL. Anyone using his share of the lead pencils manufactured in the United States uses up seven every year. About a billion pencils a year are needed to supply the country. Laid end to end, this many pencils would extend three and a half times around the earth.

Whole forests of timber must be cut to supply the wood for these pencils. The only really satisfactory wood for pencils is the soft, rather "cheesy" red cedar. Most of this comes from Tennessee and California. Cheap pencils are often cased in poorer kinds of cedar and in other woods.

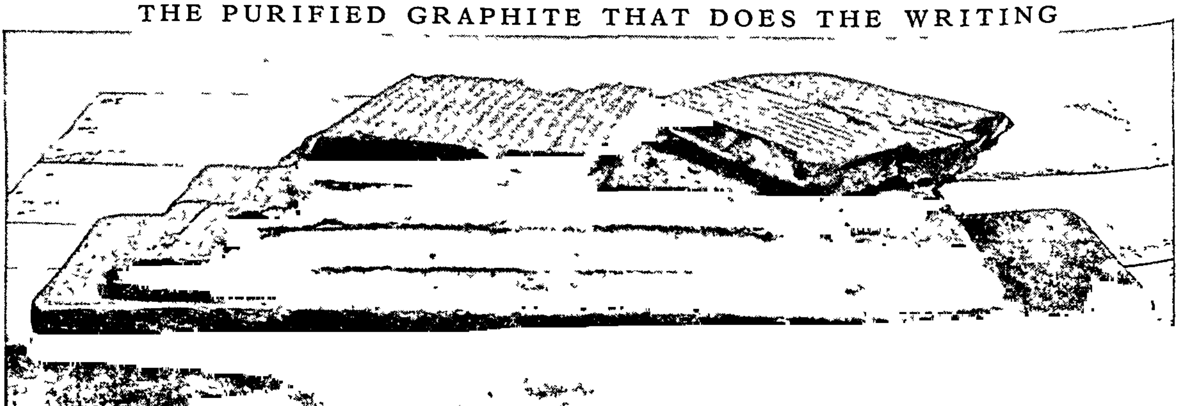
Lead pencils do not contain lead, but graphite, a form of carbon (*see* Graphite). Lead was once used for marking, however, and we still use this name. The graphite as it comes from the earth is refined, pulverized, and mixed with fine clay to produce leads of various degrees of hardness. Sometimes a little lampblack is added to increase the blackness.

The thick, doughy mixture is squeezed through perforations in a plate until it is smooth, and then through a perforation the size of the finished lead. As the long, black strings come out, they are nipped off in pieces of the right length, straightened, and allowed to dry. After drying, the pieces are packed into trays, sprinkled with carbon dust, and baked for several hours to extract all moisture.

The leads are then ready for the cases. These are made by milling the wood into seven-inch *slats* and cutting from four to seven grooves in these. The leads are slipped into the grooves, which are just big enough to hold them, and a cover slat is glued on and clamped. When these *blocks* have dried sufficiently, a shaping machine mills each of them into a number of perfectly formed pencils. These are then painted, labeled, tipped with erasers, and boxed.

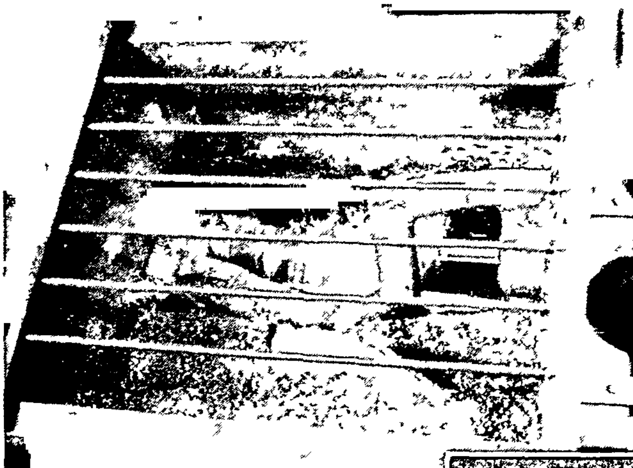
Colored pencils are made by mixing coloring matter with chalk, clay, or wax. Carpenters' pencils and china-marking ("grease") pencils, which are very

THE PURIFIED GRAPHITE THAT DOES THE WRITING



To purify graphite for pencils, it is pulverized and mixed with hot water. This mixture is passed from tub to tub until the impurities that would form hard spots in pencil leads settle. A filter press removes the water and leaves the graphite in slabs like these.

SOME IMPORTANT STEPS IN THE MAKING OF PENCILS



1. A mill mixes the graphite with clay and water into a dough that will be squeezed through dies to form long strings of "lead." 2. After being cut and air dried, the leads are placed in crucible boxes and are tempered and toughened in ovens at white heat. 3. Red cedar slats for the casings are seasoned and dried before they are grooved to receive the leads. 4. After many other operations, the completed pencils are carefully inspected, and the perfect ones are packed for shipping.

soft, have a little wax and tallow added to the graphite. Some very soft pencils are made with a cover of paper strips, wound spirally and glued. They are "sharpened" by unrolling the paper a strip at a time.

While not as old as the pen, the lead pencil has a long history. In the Middle Ages, scribes used the metal lead for ruling faint lines on parchment. About 1400, graphite appeared and was given the name "black lead." Discovery, in the 16th century, of a mine of extremely pure graphite in the Borrowdale Valley of northern England hastened the adoption of graphite lead pencils. The English graphite could be cut in rods and used without further manufacture. When the Borrowdale mine ran out, pencil makers were forced to use graphite of lower purity. This had to be pulverized and mixed with a binder. Many were tried, and in 1795 the present-day clay binder proved successful.

The lead pencil has had its present form since the latter part of the 17th century. Earlier, metal clips were used to hold the graphite rods, or the rods were wrapped with twine that was unwound as the pencil was used. Finally, about 1686, a method was developed for casing the graphite in wood.

Today mechanical, or automatic, pencils offer some competition to lead pencils because they do not have to be sharpened. A popular form of mechanical pencil has a casing of metal and a lead that slips out at the point as needed. When a new lead is inserted at the point, it is caught in a clutch on the end of a rod that bears a projecting stud on one side. This stud is seated in a spiral groove cut along the length of a cylinder inside the casing and connected to the cap. Turning the cap turns the cylinder, and the stud of the clutch moves down or up in the spiral, causing the lead to protrude for writing or to withdraw into the casing. Extra leads are carried in a magazine, which is usually topped with an eraser.

PENDULUM. One day in 1583 a youth of 19 made a great discovery. The scene was the cathedral of Pisa, in which a great lamp swung to and fro on a long chain. The youth timed the vibrations of the lamp by his pulse, and found that no matter how the length of the swings varied, they were always finished in the same time. From this discovery of Galileo's (*see* Galileo) grew the *pendulum*—still used in many clocks of our day (*see* Watches and Clocks).

If we pull a pendulum slightly to one side of its position of rest and then release it, it swings downward under the pull of gravity until it reaches the center. Then its *momentum* carries it beyond this point. Soon gravity overcomes momentum, and the pendulum starts back. It swings to and fro until it stops, but the time of each beat or "oscillation" is always the same. The only factors affecting the period of the pendulum are the force of gravity and the length of the rod. This swinging of equal arcs in equal times is called "isochronism."

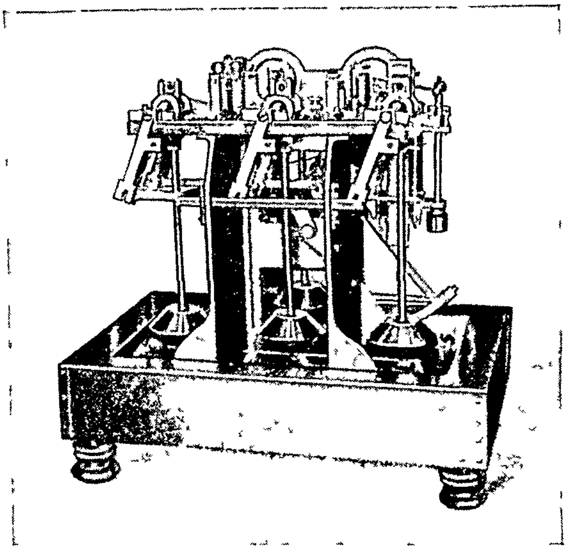
We can control the period of a pendulum, therefore, by adjusting its length. Every pendulum now has a screw below the weight, or "bob," by which it can be raised or lowered on the rod, to regulate the time of beating. Temperature variations also affect pendulums, because a rising temperature causes the metal of the rod to expand and lengthen, and the beat is slower. This effect is largely neutralized in "compensating" pendulums. These replace the simple rod with bars of dissimilar metals side by side, each bar being connected at the top to its neighbor on one side, and at the bottom to the other neighbor, out to the end bars. Since the different metals expand unequally, and the arrangement of the bars cancels the upward expansion of one bar by the downward expansion of another, the length of the assembly remains practically unchanged, through wide temperature changes. The alloy invar (*see* Nickel), which is scarcely affected by temperatures, is often used for making high-grade pendulums, particularly for scientific instruments.

Another compensation method widely used has a deep cup of mercury as the bob. This is proportioned so that the expansion of the mercury lifts its mass enough to compensate for the lengthening of the rod.

"Torsion" or twisting pendulums obey different laws. They are weights supported by fine threads of quartz or wire. As the weight turns slowly on the axis formed by the wire it twists the wire, shortening it slightly, and thus lifts itself against gravity. When gravity and the resistance of the wire to further twisting equal the twisting force, the twisting stops and the wire untwists, turning the weight the other way. Momentum carries the weight through the midpoint—so the arrangement twists one way, then the other, just as a pendulum swings, provided small impulses are given to compensate for frictional losses. A watch balance wheel has a motion to and fro much like a torsion pendulum.

A given pendulum will beat faster in high latitudes than at the Equator, since the force of gravity is strongest at the poles. A pendulum beating seconds at New York City would be 39.101 inches long; it would be about 39.020 inches at the Equator.

A SEAFARING PENDULUM



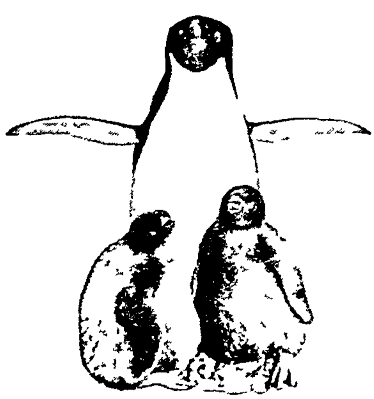
Dr. F. A. Vening Meinesz, a celebrated Dutch scientist, devised this complicated apparatus to measure accurately the force of gravity at sea. Mirrors on the pendulums reflect light, and the beams combine into one, swinging in perfect unison no matter how the boat moves about on the surface of the sea or is tossed by the waves.

Pendulums of fixed length also beat slower when taken above sea level, since moving them farther from the center of the earth lessens the force of gravity. This effect is so precise that pendulums afford the best means of measuring altitudes. Those used by the United States Coast and Geodetic Survey are marvels of precision. Special forms have been devised for use at sea. Foucault used the pendulum to demonstrate the rotation of the earth, and others to weigh it (*see* Earth).

PENGUIN. Seen from a distance, a colony of these strange sea birds of the Southern Hemisphere might easily be taken for an assemblage of little men. They stand erect and flat-footed, often drawn up in long regular files, like soldiers, and they walk with a tread so stately and dignified that the sight is irresistibly comical. In the species known as the king penguin, the resemblance to man is heightened by the coat of grayish-blue which covers the back, set off by the black plumage of the head and the white of the breast, with a yellow cravat at throat.

The penguin looks more like "a caricature of a big fat human being than an ordinary diving bird," says the celebrated naturalist William Hornaday; and it was this ludicrous resemblance to mankind that led Anatole France, the great French novelist, to write his famous story 'Penguin Island'. In this he tells of a snow-blinded missionary who was driven by a storm to a remote shore. Upon landing he was surprised to find, as he supposed, the inhabitants assembled to meet him. As they stood about him, he preached to them, and interpreting their nodding and bowing as signs of assent, he performed the rites

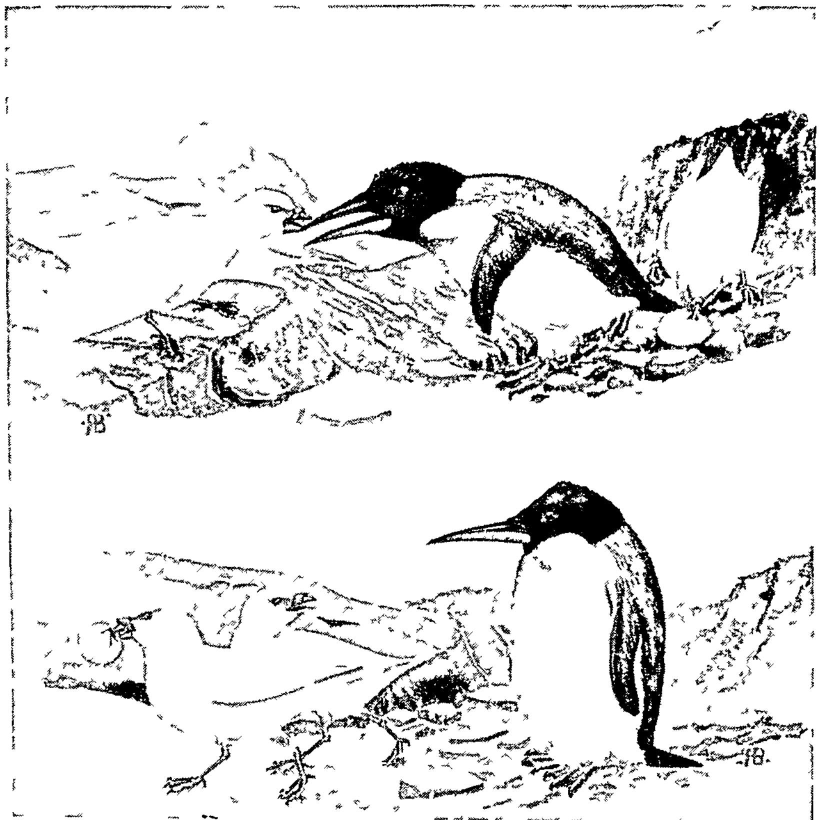
HOW PENGUINS GREET ANTARCTIC SPRING



Above, Adélie penguins pose, doze, bow, chatter, swagger, and nest in a typical breeding colony or rookery. They arrived at their breeding ground in mid-October (Antarctic springtime) after wintering on oceanic ice packs. Lower left, a penguin suitor shows off his "waistcoat" while the hen of his choice coyly cocks her head. Next, a parent proudly presents twins of sooty gray. Though almost buried by a spring blizzard, a sitting penguin (lower right) faithfully guards the nest.

of baptism upon them. Great was the surprise of the good man when he later discovered that he had been speaking to a colony of penguins!

A TRAGI-COMEDY IN THE ANTARCTIC



Of all egg-stealers, undoubtedly the worst robber is the sheathbill, an Antarctic bird which haunts the rookeries of penguins and shags. Here you see two sheathbills getting a meal at the expense of a poor helpless penguin. One of the sheathbills annoys the penguin, who reaches forward to attack, thus leaving her nest unprotected. The second makes a thrust at the egg with its sharp beak, and the two thieves triumphantly march away with their booty, while the simple-minded penguin is apparently still unconscious of her loss.

This story might seem more plausible if the fossil penguin of prehistoric ages, which stood 6 feet high, were still in existence. The largest penguins of today, which belong to the emperor penguin species, stand about 3½ feet high, but they weigh about 80 pounds.

Ages ago the penguin could fly as well as any other sea-bird, but today its wings are short paddle-like flappers, entirely useless for flight. Since the bird inhabits only remote lands, in or near the Antarctic regions, where it has few human or animal enemies, it came to spend all its time on land or in the water. Generation after generation it failed to use its wings for flying, and so in the course of long evolution those wings became very small and stiff and lost their long feathers, until now they cannot be moved at the middle joint like the wings of flying birds. But the penguins became wonderful divers and swimmers, using their wings one after the other as a man paddles a canoe with a double paddle, and steering with their feet. They also developed a very thick coat of fat to protect them from the intense cold of the regions where they live. This fatty layer may finally lead to the extinction of the penguin, like the great auk of North America, unless it is protected by laws; for hunters now kill the birds in enormous numbers and boil them down for oil. Fish is the penguin's chief food, so the fat and oil have a disagreeable fishy flavor.

The haunts of these birds are the islands of the Pacific Ocean and the Antarctic regions, and the rocky coasts of New Zealand, Australia, and parts of South America. There they nest in great colonies and from their nesting places is collected some of the fertilizer called guano.

The one or two chalky white eggs are laid in a crude nest on the ground. The baby birds are born covered with down, and require care for a long period. In some species not only the parents, but solicitous neighbors feed and care for a single young bird. The grown birds bite savagely when molested, but they show little fear of man, since for generations they have lived in regions where human beings are rarely seen.

Penguins form the family *Spheniscidae* of the order *Sphenisciformes* There are about six genera. Scientific name of emperor penguin, *Aptenodytes fosteri*, of king penguin, *Aptenodytes longirostris*, of Adélie penguin, *Pygosceles adeliae*

PENN, WILLIAM (1644–1718). The despised and persecuted sect of Quakers were greatly elated when William Penn, the talented young son of Admiral Penn, became an open convert to their religious views, taking so prominent a part in their demonstrations that he was expelled from Oxford where he was then a student At first the admiral stormed at his son, for King Charles II was about to raise the elder Penn to the peerage but drew back when he heard that the son had become a Quaker. The father's anger, however, was short-lived; he soon forgave him, and the rich and highly placed William Penn became the most prominent Quaker in England.

Likewise, William Penn became the most famous of all the colony-builders of America. His province of Pennsylvania (or "Penn's woods") was a princely domain more than 50,000 square miles in area. The land was granted to him by King Charles II in 1681, in payment of a debt owed by the Crown to Admiral Penn and inherited by William upon the death of his father. William Penn had frequently suffered persecution and imprisonment for his religion in England. Neither could he nor his fellow-sufferers find a place of refuge in any of the established colonies of America,

for the Quakers were regarded as undesirable citizens. It was, therefore, to found a haven for people of all creeds or of no creed that Penn in 1681 sent out the first settlers to his colony of Pennsylvania

Although the power to make laws, establish courts, and otherwise regulate the affairs of the colony was conferred upon Penn by the king, he established a popular government, giving to the people the right to elect an assembly which should make their own laws.

Penn's most conspicuous success was in his dealings with the Indians. Soon after his arrival in the colony in October 1682, he entered into negotiations with the Delaware Indians. Several treaties of friendship were concluded. The most famous was signed, according to tradition, on June 23, 1683, under a great elm tree on the banks of the Delaware. It provided that the English and the Indians would "live in love as long as the sun gave light." For more than 70 years thereafter (until the French and Indian War) Penn's ideal of open and fair treatment kept this territory at peace while other colonies were suffering Indian warfare.

WILLIAM PENN
Founder of Pennsylvania

Penn had established a home in Philadelphia, the capital of his colony, and there he would gladly have spent the remainder of his life; but after two years in the colony he was called back to England by business and was detained there for 15 years.

After the Revolution of 1688, which brought William and Mary to the throne of England and Scotland, Penn was suspected of giving aid and comfort to the dethroned James II, and was once arrested for treason. In 1692 he was deprived of his colony, but two years later, the charges against him having been dismissed, he regained Pennsylvania. In 1699 he revisited his province.

Vast changes had taken place during his absence. Twenty thousand people now inhabited the province. Many of them knew nothing of William Penn except that he owned their colony and possessed rights which they wished to exercise. They demanded an even more democratic government than Penn had given them before. He granted their request, and in 1701 signed a charter (the "Charter of Privileges") which remained in force for 75 years—until the Revolution.

Late in the same year, business forced Penn to return to England and leave his beloved colony, which he was never to see again. Troubles crowded fast upon him. He got into money difficulties, and spent nine months in a debtor's prison rather than pay the extortionate claims of a swindling steward. Friends came to his aid and obtained his release, but not until his health had been permanently impaired. His last years were further vexed by quarrels with Lord Baltimore, the proprietor of Maryland, by disagreements with the people of his province, and by the dissipations of one of his sons. He was making arrangements to surrender his colony to the Crown when he was stricken with paralysis; and so Pennsylvania became the property of his descendants. Their rights, except to private estates, were sold to the Commonwealth of Pennsylvania during the Revolutionary period.

William Penn was the author of a number of works, among which the chief were: 'No Cross, No Crown', a work of Christian piety; 'The Great Case of Liberty of Conscience', an able defense of religious toleration; and 'The Present and Future Peace of Europe', a work which may be said to have foreshadowed the Hague Tribunal and the League of Nations. His 'Fruits of Solitude', a treasury of wise maxims on life and conduct, is still widely popular.

The KEYSTONE STATE, *a* TITAN *of* INDUSTRY

PENNSYLVANIA. The nickname "Keystone State" was given Pennsylvania more than 150 years ago. When the Union of 13 states was formed, six states were north of Pennsylvania and six were south. Pennsylvania was the "keystone of the arch."

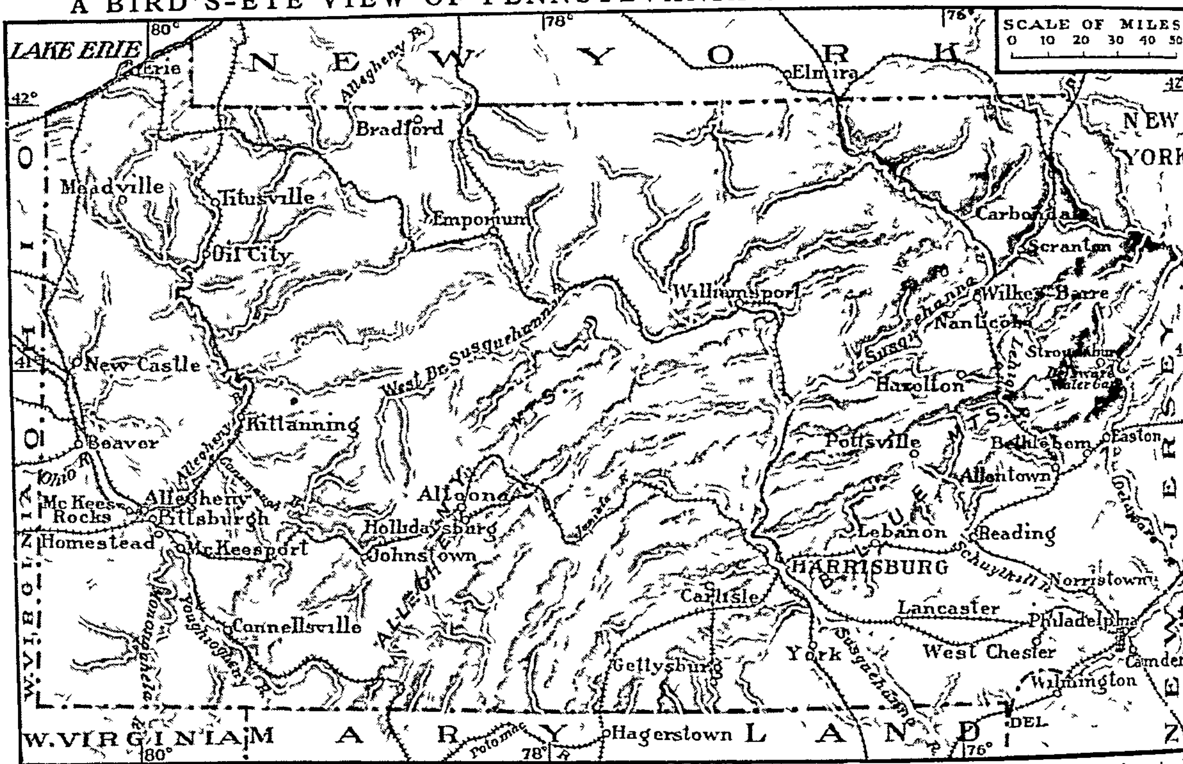
It is still a keystone state not only because of its geographical location, but also because of its immense natural resources, vast industrial development, and great population. Only New York and California exceed it in population, only New York in value of manufactured goods, and only Texas in value of minerals. In steel and many steel products, all-important to the nation and the world, Pennsylvania ranks first.

The name Pennsylvania means "Penn's Woods." Charles II gave the province this title, honoring Penn's father, when he granted it to William Penn in 1681. The next year Penn established the colony as the "Commonwealth of Pennsylvania." After it became a state in 1776 this remained the official name.

Natural Wealth of the State

Pennsylvania's boundaries bespeak its keystone position. The state starts from the Delaware River, in colonial times the most important water channel into the New World. To the south, the boundary arcs around little Delaware, following the line surveyed under a warrant from William Penn in 1701. Beyond the arc the boundary is Mason and Dixon's line, which separated free states and slave states until the Civil War. The northern boundary sweeps westward more than 200 miles, then hooks northward near the northwest corner to include a strip of land and a port on Lake Erie. This tract, known as the Erie Triangle, was bought from the United States government in 1792 to get the port. George Washington signed the deed.

A BIRD'S-EYE VIEW OF PENNSYLVANIA'S HILLS AND VALLEYS



Rising from the Piedmont in the southeast part of the state, the broad Appalachian area crosses from northeast to southwest. In the west is a high plateau, deeply carved by rivers into a mountainous terrain.

Within these boundaries Pennsylvania presents a rich expanse of mountains and plains, cut by deep rivers and valleys. The Piedmont Plateau that runs north and south through the Atlantic States cuts diagonally across the southeast corner of Pennsylvania. Rising from the Piedmont are the Blue Mountains, the outliers of the broad Appalachian range that traverses the state from northeast to southwest. Beyond the Blue Mountains and the valleys formed by the Susquehanna and its tributaries are the Alleghenies. In the southwest in the Negro Mountains is Mount Davis, the highest point in the state, with an altitude of 3,213 feet. In the northeast rise the Pocono Mountains, an extension of New York State's Catskill plateau. The Poconos are a favorite resort area. The main passes through the mountain regions are the valleys of the Delaware River in the east, the Allegheny River in the west, and the Susquehanna River in the center. Its branches join at Sunbury.

West of the Alleghenies is a broad plateau, made up of broad tableland carved into deep valleys and mountains by rivers. Here the Allegheny River flowing southward and the Monongahela River flowing northward join to form the Ohio River at Pittsburgh. The entire western section is from 1,000 to 1,500 feet above sea level.

Pennsylvania's climate varies with its regions. In the southeast, winters are mild and summers often hot and humid, with heavy rainfall during the occasional autumn hurricanes. In the mountains the average number of below-freezing days is above 100. The valley lands are comparatively free from damaging frosts, and rainfall is well

AMERICA'S MUSHROOM STATE

Most of the nation's mushrooms are grown in Pennsylvania, in specially built buildings. To control the temperature, the foundations are made of concrete, the double walls are insulated, and no sunshine is admitted to the rooms.

distributed over the crop-growing seasons. Annual precipitation varies from 34 inches in the north central region to 50 in the southwest.

Although Pennsylvania was once almost covered with dense forests, it no longer ranks among the important lumber states. Large-scale lumbering operations in early days cleared more than half of its forests. Today the state has about 15 million acres of forests, about four fifths privately owned. The Allegheny National Forest includes about 720,000 acres; another $1\frac{3}{4}$ million acres are in state forests.

Wealth from Manufacturing

Pennsylvania is one of the great industrial states. It ranks third after New York and Ohio in the value of its manufacturing. About a third of its workers are employed in its thousands of factories and mills.

The tremendous output of Pennsylvania's blast furnaces, steel mills, and foundries accounts for its largest industry—the production of primary metals. Iron and steel are produced in all but six of its 66 counties. Most of the steelworks are near Pittsburgh, in one of the nation's largest steel-producing areas. A huge steel mill began operation in 1952 near Morrisville on the Delaware River. It uses Venezuelan ore.

The manufacture of machinery is next to steel in importance. Refrigeration and textile machinery and valves and fittings are the main products. Other large industries are the manufacture of fabricated metal products, textiles, and food products.

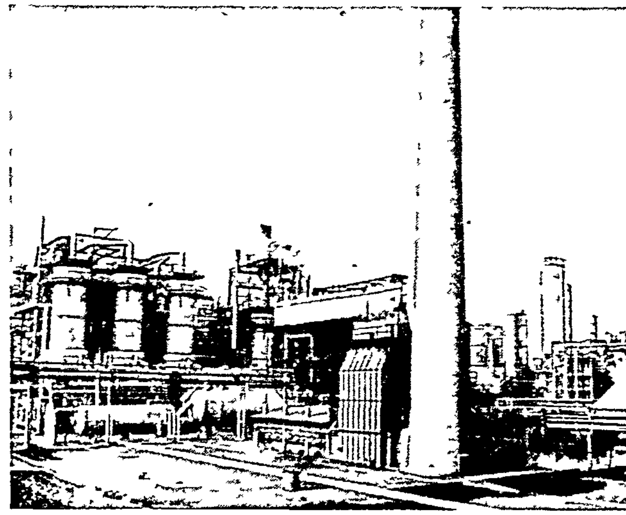
Minerals for Pennsylvania's Industries

Pennsylvania's high rank as a manufacturing state is mainly due to its access to raw materials. In the early days of American industrial development, the state had unlimited coal deposits and enough iron ore, limestone, and other materials needed to make pig iron and steel. With the increase in demand, its supplies of iron ore were soon exhausted. Before they were gone, however, enormous deposits of high-grade ore were discovered in Michigan and Minnesota across the Great Lakes. This ore could be delivered to the Pennsylvania furnaces and mills by cheap water transportation. Along with Pennsylvania and West Virginia coal, these ore deposits aided the swift growth of the state's iron and steel industry.

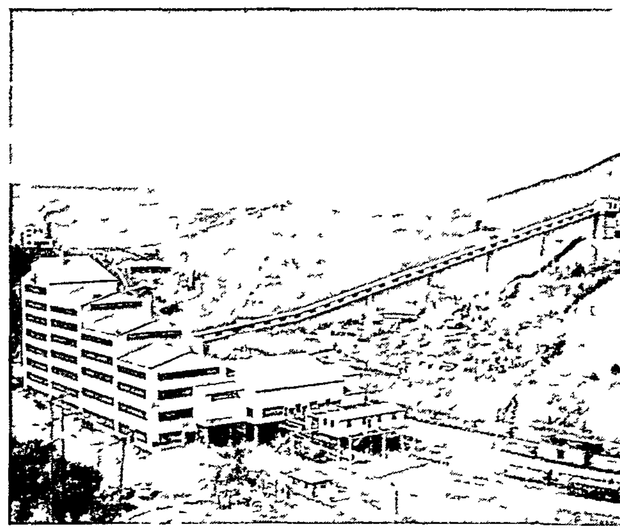
Today great fleets of ore boats and barges from ports in the Lake Superior region ply through the Great Lakes to docks on the Ohio and Pennsylvania shores of Lake Erie. There the ore is transferred to railroad cars which carry it to blast furnaces and steel mills in the Pittsburgh area. At the same time, railroads and river barges haul Pennsylvania and West Virginia coal to the furnaces and mills. They also bring Pennsylvania limestone, which is essential to the manufacture of iron and steel.

The state still has vast reserves of coal. It ranks first in the nation in coal mining, producing about 30 per cent of the total supply. It mines practically all the country's anthracite, which is used principally for heating. It ranks second only to West Virginia in the production of bituminous coal. This "soft" coal is used chiefly by mills and fac-

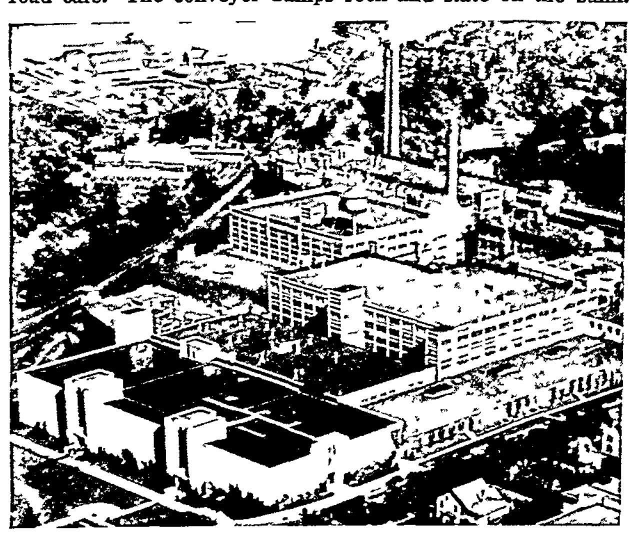
A GREAT INDUSTRIAL STATE



Most people know Pennsylvania as the "Iron and Steel State," but its manufactures are varied, as these pictures show. This large oil refinery at Marcus Hook produces aviation gasoline.



At Mahanoy City, in the heart of anthracite fields, is one of the world's largest coal breakers. Here coal is loaded into railroad cars. The conveyer dumps rock and slate on the bank.



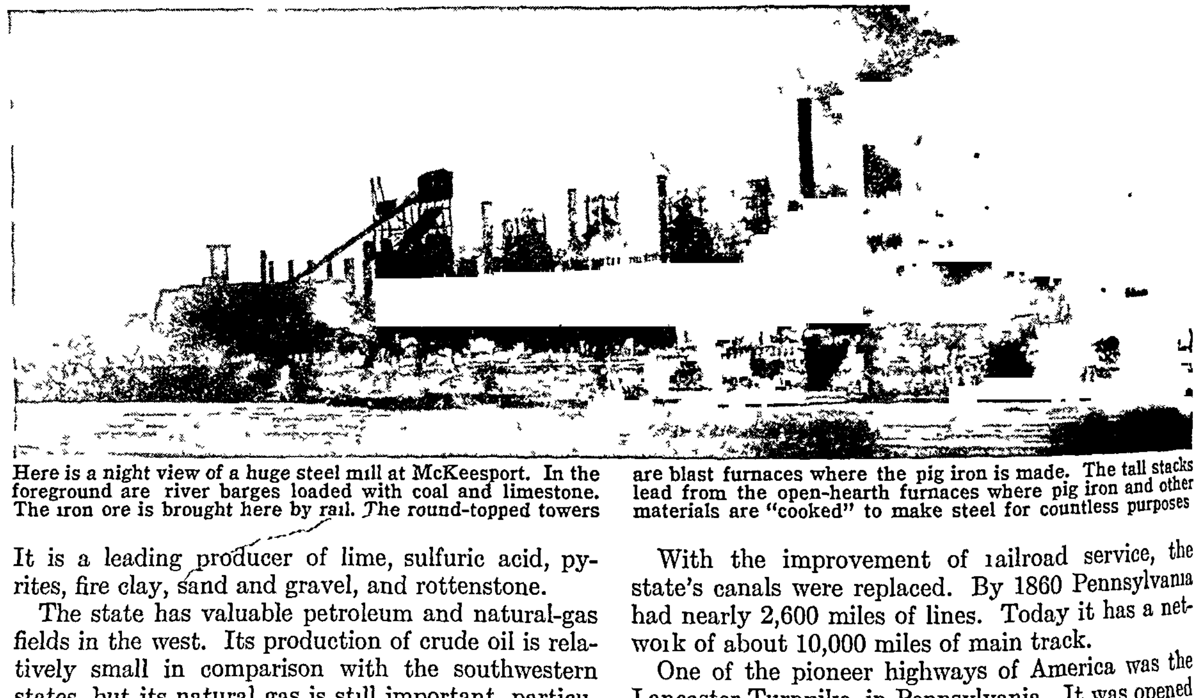
Milton S. Hershey founded the town of Hershey in 1903. On a cornfield he built the world's largest chocolate and cocoa factory and many community facilities for education, work, and play.

tories (including coke and by-product plants), railroads, and steam-electric power plants. Much of the coal mined is sold within the state but large quantities are shipped to Eastern cities and abroad.

The entire Appalachian bituminous coal fields extend over an underground area of about 70,000 square miles. About one fourth of this area is in western Pennsylvania. The state's anthracite fields are in the Wyoming Valley near Scranton and Wilkes-Barre.

Pennsylvania is first among the states in production of coke, pig iron, stone, cobalt, slate, and cement.

VULCAN'S FORGE IN A MODERN SETTING



Here is a night view of a huge steel mill at McKeesport. In the foreground are river barges loaded with coal and limestone. The iron ore is brought here by rail. The round-topped towers are blast furnaces where the pig iron is made. The tall stacks lead from the open-hearth furnaces where pig iron and other materials are "cooked" to make steel for countless purposes

It is a leading producer of lime, sulfuric acid, pyrites, fire clay, sand and gravel, and rottenstone.

The state has valuable petroleum and natural-gas fields in the west. Its production of crude oil is relatively small in comparison with the southwestern states, but its natural gas is still important, particularly to the glassmaking industry.

Pennsylvania is second only to New York in the capacity of its generating plants. Its power stations together can generate a steady output of some 6½ million kilowatts of electricity. About 90 per cent of this power comes from steam-electric stations which are stoked almost entirely with bituminous coal from Pennsylvania mines.

Varied Farming on the Available Land

Although much of its land is too mountainous for farming, Pennsylvania has many areas suitable for agriculture. In total cash income from farm products it ranks 14th among the states. Its most important farm products are milk, eggs, corn, hay, cattle, chickens, hogs, and wheat. It also grows potatoes, oats, barley, tobacco, buckwheat, and rye. It raises sheep, lambs, and turkeys. In yield of wheat and most other small grains, it usually leads all states east of Ohio. Pennsylvania produces large quantities of truck crops and a good yield of apples, pears, peaches, and grapes. Mushrooms are a specialty.

The state has many skillfully managed farms. In the eastern part are the well-tended crop and dairy farms of the Quakers and Pennsylvania Germans. Elsewhere, in the mountain valleys and on the western plateau there are good pastures and fine orchards, as well as small crop farms.

Water and Land Transportation

During the first half of the 1800's canals played an important part in the internal development of Pennsylvania. By 1830 the state had more than 700 miles of canals, with many more miles under construction. These water routes offered strong competition to New York's Erie Canal for trade with the West.

With the improvement of railroad service, the state's canals were replaced. By 1860 Pennsylvania had nearly 2,600 miles of lines. Today it has a network of about 10,000 miles of main track.

One of the pioneer highways of America was the Lancaster Turnpike, in Pennsylvania. It was opened in 1794 and extended about 64 miles between Philadelphia and Lancaster (*see* Roads and Streets). Today the state has about 88,000 miles of rural roads.

Among the finest highways in the nation is the Pennsylvania Turnpike. It is a safe, high-speed route that tunnels under mountains and by-passes towns between the Ohio border and suburbs of Philadelphia. The 327-mile expressway runs near Pittsburgh and Harrisburg. Links with the New Jersey Turnpike and to the northeast part of the state are in work.

The state has a huge volume of ocean and lake shipping. Its main ocean port is Philadelphia, which is second only to New York City in foreign and coastwise tonnage handled every year. Ocean vessels use the city's docks and the channel of the Delaware River and Bay. The Delaware is navigable for small vessels as far up as Trenton, N. J.

A State of Many Busy Cities

Most of the people of Pennsylvania live in its many cities. The largest city, and third most populated in the nation, is Philadelphia. Pittsburgh, the second largest city in the state, is an industrial center in western Pennsylvania. (*See* Philadelphia; Pittsburgh.)

Continued on page 137

Pennsylvania Fact Summary

PENNSYLVANIA (Pa.): Named for William Penn's father. Also from *penn*, Celtic for "head," and *sylvania*, New Latin for "woodland." Common meaning, "Penn's Woods."

Nickname: "Keystone State," from its central position in the arch of the 13 original colonies.

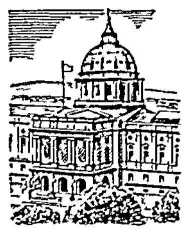
Seal: Upon a shield, a ship in full sail in top section; a plow, in middle section; 3 sheaves, in lowest section. Eagle perches above shield; to right of shield, olive branch; to left, stalk of corn.

Motto: Virtue, Liberty, and Independence.

Flag: For description and illustration, *see* Flags.

Flower: Mountain laurel. **Bird:** Ruffed grouse. **Tree:** Hemlock. **Song:** None official.

THE GOVERNMENT



Capital: Harrisburg (since 1812).

Representation in Congress: Senate, 2; House of Representatives, 30. Electoral votes, 32.

General Assembly: Senators, 50; term, 4 years. Representatives, 210; term, 2 years. Convenes first Tuesday in January in the odd-numbered years. There is no limit to the length of the session.

Constitution: Adopted, 1874. Proposed amendment must be (a) passed by majority vote of both legislative houses at 2 successive sessions and (b) ratified by a majority voting on amendment at a popular election.

Governor: Term, 4 years. May not succeed himself.

Other Executive Officers: Lieutenant governoı, treasurer, auditor general, secretary of internal affairs, all elected; terms, 4 years. Secretary of commonwealth and attorney general appointed by governor (confirmation by two-thirds senate); terms, at governor's pleasure.

Judiciary: Supreme court—7 justices, elected at large; term, 21 years. Courts of common pleas—59 districts; superior court—7 judges; all judges in these courts are elected for 10-year terms.

County: 67 counties, each governed by a board of 3 commissioners and 3 auditors, elected for 4-year terms; other officers elected; terms, 4 years.

Municipal: Cities—commission or mayor-council; boroughs and towns—burgess and council or city manager.

Voting Qualifications: Age, 21; residence in state, 1 year; in district, 2 months.

TRANSPORTATION AND COMMUNICATION

Transportation: Railroads, 9,700 miles. First railroad, Gravity Railroad (Summit Hill to Mauch Chunk), 1827. Rural roads, 88,000 miles. Airports, 208.

Communication: Periodicals, 425. Newspapers, 565. First newspaper, *American Weekly Mercury*, Philadelphia, 1719. Radio stations (AM and FM), 166; first station, KDKA, Pittsburgh—received telephone apparatus license Oct. 27, 1920, and radio broadcast license Nov. 7, 1921. Television stations, 20; first station, WPTZ, Philadelphia, began operation Sept. 16, 1941. Telephones, 3,647,600. Post offices, 2,382.

THE PEOPLE AND THEIR LAND

Population (1950 census): 10,498,012 (rank among 48 states—3d); urban, 70.5%; rural, 29.5%. Density: 233.1 persons per square mile (rank—7th state).

Extent: Area, 45,333 square miles, including 288 square miles of water surface (32d state in size; same rank if Great Lakes area of 735 square miles is added).

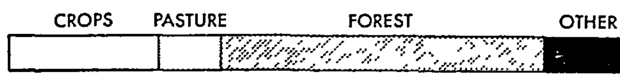
Elevation: Highest, Negro Mountains (Mount Davis), 3,213 ft. nr. Listonburg; lowest, Delaware R., sea level.

Temperature (°F.): Average—annual, 50°; winter, 29°; spring, 49°; summer, 70°; fall, 53°. Lowest, −42° (Smethport, Jan. 5, 1904); highest, 111° (Phoenixville, July 10, 1936, and other locations and earlier dates).

Precipitation: Average (inches)—annual, 42; winter, 9; spring, 11; summer, 13; fall, 9. Varies from about 34 in north central to about 50 in southwest.

Natural Features: Blue Ridge and Allegheny mountains divide state into 3 sections. Eastern section, gently rising lowlands of Piedmont Plateau; middle section, mountainous, heavily wooded; western section, hilly countryside, and plains along shore of Lake Erie. Principal rivers: Allegheny, Delaware (forming eastern boundary), Monongahela, and Susquehanna.

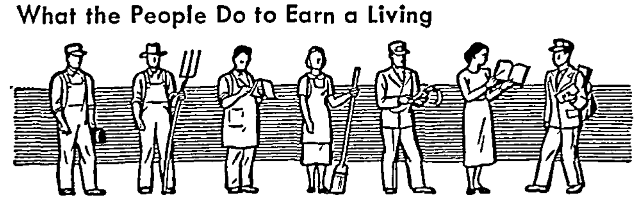
Land Use: Cropland, 24%; nonforested pasture, 10%; forest, 52%; other (roads, parks, game refuges, wasteland, cities, etc.), 14%.



Natural Resources: *Agricultural*—fertile valleys in Appalachian Mountains; adequate rainfall. (*Industrial*—anthracite and bituminous coal, limestone and clays for cement, stone, petroleum, and natural gas; hardwood forests. *Commercial*—central location in Middle Atlantic region; rivers and Great Lakes for water transportation.

OCCUPATIONS AND PRODUCTS

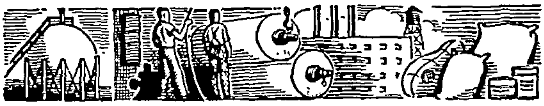
What the People Do to Earn a Living



Major Industries and Occupations, 1950

Fields of Employment	Number Employed	Percentage of Total Employed
Manufacturing	1,396,320	35.5
Wholesale and retail trade	689,802	17.5
Transportation, communication, and other public utilities	330,906	8.4
Professional services (medical, legal, educational, etc.)	311,498	7.9
Construction	215,872	5.5
Personal services (hotel, domestic, laundering, etc.)	197,083	5.0
Mining	192,253	4.9
Agriculture, forestry, and fishery	164,804	4.2
Government	145,103	3.7
Finance, insurance, and real estate	116,400	3.0
Business and repair services	88,836	2.3
Amusement, recreation, and related services	29,946	0.8
Workers not accounted for	52,346	1.3
Total employed	3,931,169	100.0

Pennsylvania Fact Summary



What the People Produce

A. Manufactured Goods (Rank among states—3d)
Value added by manufacture* (1952), $9,673,846,000

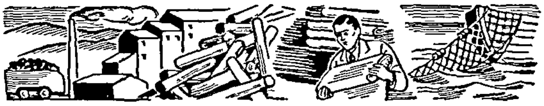
Leading Industries in 1947 (with Principal Products)	Value Added by Manufacture	Rank among States
PRIMARY METAL INDUSTRIES..... Blast furnace, steel mill and iron and steel foundry products	$1,219,042,000	1
MACHINERY (EXCEPT ELECTRICAL) Refrigeration machinery; valves and fittings; textile machinery	665,443,000	5
TEXTILE MILL PRODUCTS........ Knitting mills; carpets and rugs; rayon broad-woven fabrics	621,448,000	2
FOOD AND KINDRED PRODUCTS.... Bakery products; malt liquors; distilled liquors; confectioneries	586,025,000	4
FABRICATED METAL PRODUCTS.... Structural metal products; metal stamping and coating	533,319,000	3

*For explanation of value added by manufacture, *see* Census.

B. Farm Products (Rank among states—14th)
Total cash income (1952), $821,209,000

Products	Amount Produced (10-Year Average)	Rank within State*	Rank among States†
Milk............	2,422,000,000 qts.	1	8
Eggs............	223,000,000 doz.	2	4
Corn............	56,275,000 bu.	3	16
Hay............	3,542,000 tons	4	11
Cattle...........	305,922,000 lbs.	5	20
Chickens........	171,029,000 lbs.	6	3
Hogs............	225,692,000 lbs.	7	22
Wheat..........	18,440,000 bu.	8	18

*Rank in dollar value †Rank in units produced



C. Minerals (Fuels, Metals, and Stone)
Annual value (1951), $1,289,226,000
Rank among states—2d

Minerals (1951)	Amount Produced	Value
Bituminous coal.....	108,164,000 tons	$572,194,000
Anthracite..........	42,670,000 tons	405,818,000
Cement.............	41,560,000 bbls.	107,036,000
Petroleum..........	11,345,000 bbls.	48,220,000
Stone..............	27,400,000 tons	46,669,000

D. Lumber (Rank among states—17th)
503,000,000 board feet (5-year average)

E. Trade

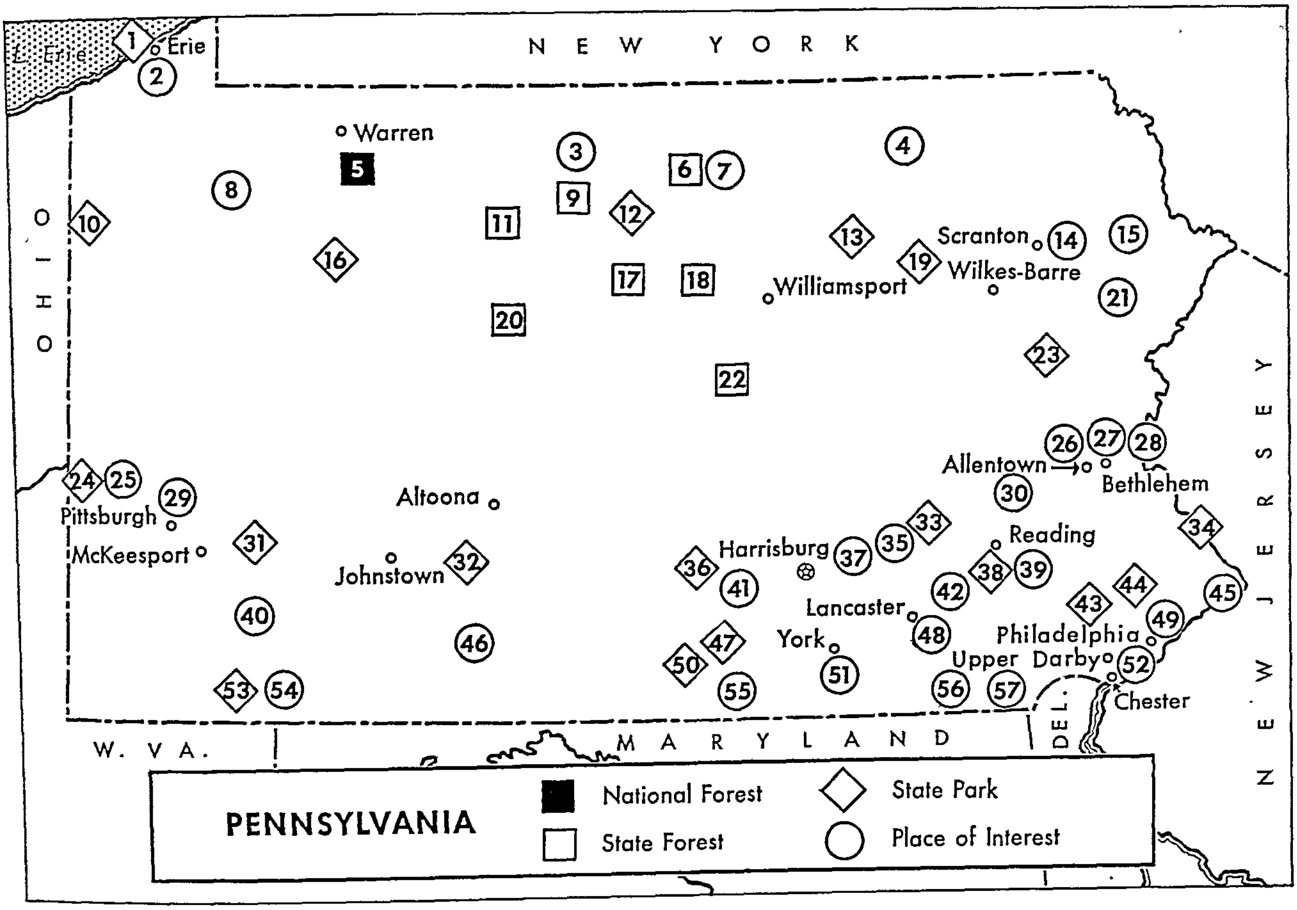
Trade (1948)	Sales	Rank among States
Wholesale.......	$11,084,459,000	4
Retail..........	9,069,431,000	3
Service.........	803,846,000	4

PLACES OF INTEREST*

Ambridge—site of Economy, a Christian communal settlement (1805–1906); buildings preserved (25).
Bedford—Espy House where Washington stayed during the Whiskey Rebellion; site of Fort Bedford, early British fort captured by Americans, 1769 (46).
Bethlehem—early Moravian buildings, including the Central Moravian Church; first pharmacy in U.S. (27).
Buck Hills Falls—50-foot falls near Canadensis (21).
Caleb Pusey House—in Chester; oldest English-built house in state still intact (52).
Canal Tunnel—oldest in U. S. (1823); at Lebanon (35).
Colonel Denning State Forest Picnic Area—named for William Denning, inventor of an iron cannon for Revolutionary War Army; near Newville; northwest of (41).
Coudersport Ice Mine—huge icicles form during the summer months in a pit in side of Ice Mountain (3).
Crystal Cave—rock formations near Kutztown (30).
Daniel Boone Birthplace—near Baumstown (39).
Drake Well Memorial Park—Titusville; first oil well, drilled in 1859; museum housing early equipment (8).
Easton Public Library—displays flag believed to be first "Stars and Stripes" of United Colonies (28).
Ephrata Cloisters—buildings used by early religious group who founded this colony in 1732 (42).
Fort Necessity National Battlefield Site—opening battle of French and Indian War (1754); near Farmington; Braddock's grave nearby (54).
Fort Pitt Blockhouse—Pittsburgh; from frontier days (29).
Gettysburg Natl. Military Park—historic battle sites; national cemetery; Lincoln Speech Memorial; Gen. Meade's hdqrs.; farm of Pres. Eisenhower nearby (55).
Harrisburg—State Capitol (*see* Harrisburg); near (37).
Hershey—world's largest chocolate plant; gardens (37).
Hopewell Village National Historic Site—near Baumstown; cannon made here in Revolutionary War (39).
Lake Wallenpaupack—artificial lake near Hawley (15).
Landis Valley Museum—near Lancaster; shows life of early Dutch; Conestoga wagons, rifles, clocks (42).
Longwood Gardens—near Kennett Square; beautiful formal gardens on estate of Pierre S. du Pont (57).
Molly Pitcher Grave—Revolutionary War heroine buried in Old Graveyard at Carlisle (41).
Pennsbury Manor—reconstructed manor house of William Penn's plantation near Morrisville (45).
Philadelphia—many places of interest; Independence National Historic Park Project; Gloria Dei (Old Swedes') Church and Old Philadelphia Custom House, both national historic sites (*see* Philadelphia) (49).
Pittsburgh—Stephen Collins Foster Memorial Building; Cathedral of Learning (*see* Pittsburgh) (29).
Robert Fulton Birthplace—Lancaster County (56).
Scottdale—Historical House, a museum adjoining birthplace of steelmaster Henry Frick (40).
Scranton—tours through coal mines (*see* Scranton) (14).
Site of Asylum—near Rummerfield; location of intended refuge for aristocracy fleeing French Revolution (4).
Tinicum Island—near Glen Olden; excavated remains of early Swedish settlement (52).
Wayne Memorial—replica of blockhouse in which Gen. Anthony Wayne died in 1796; at Erie (2).
"Wheatland"—Lancaster home of James Buchanan, 15th president of U.S., from 1849 until his death (48).
York—nation's capital, 1777–78; site of Colonial Courthouse where Continental Congress met (51).
Zion's Reformed Church in Allentown—hiding place of the Liberty Bell during 1777–78 (26).

*Numbers in parentheses are keyed to map.

Pennsylvania Fact Summary



STATE PARKS AND HISTORICAL MONUMENTS*†‡

Blue Knob S.P.—view of countryside from state's second highest mountain; near Beaverdale (32).

Brandywine Battlefield H.M.—near Chadd's Ford; one of first battlefields of Revolutionary War; here British defeated Continental Army (1777); includes headquarters of Generals Washington and Lafayette; near (57).

Bushy Run Battlefield H.M.—Indians defeated in French and Indian War (1763); near Greensburg (31).

Caledonia S.P.—named for charcoal iron furnace established by Thaddeus Stevens in 1837 (50).

Colton Point S.P. and Leonard Harrison S.P.—nearby parks on 800-ft. deep Pine Creek Gorge, "Grand Canyon" of Pennsylvania; near Wellsboro; east of (6).

Conrad Weiser H.M.—museum and park dedicated to colonial interpreter and peacemaker of French and Indian War period; near Womelsdorf (33).

Cook Forest S.P.—virgin-timber stand, a preserve of original Penn's Woods; located on Clarion River (16).

Cowan's Gap S.P.—near McConnellsburg; water sports on lake formed by dam; northwest of (50).

Fort Necessity H.M.—battle of Great Meadows, first battle in French and Indian War, between Colonials and French and Indians (1754); near Uniontown; national battlefield site (53).

Fort Washington H.M.—site of historic fort located on Fort Hill; includes Militia Hill (44).

French Creek S.P.—large picnic area surrounding an early ironmaking feudal village; near Baumstown (38).

George W. Childs S.P.—near Dingman's Ferry; forest tract with three beautiful waterfalls; northeast of (21).

Greenwood Furnace S.P.—near Belleville; ruins of an early iron furnace; tree nursery; northwest of (41).

Halfway S.P.—named for early settlement midway between Mifflinburg and Centre Hall; flat basin amid mountains; lake and observation tower; at (22).

Hickory Run S.P.—unusual geological formations; waterfalls and fishing streams; near Albrightsville (23).

Kettle Creek S.P.—near Westport; kettlelike formation in mountains; lake near mountaintop; southwest of (12).

Laurel Hill S.P.—near Somerset; dam forms lake high up in rolling, forested mountains; northeast of (53).

Ole Bull S.P.—near Oleona where the Norwegian violinist attempted to settle a Norwegian colony (12).

Pennsylvania State Park at Erie H.M.—nearly all of Presque Isle Peninsula across bay from city of Erie; here Perry constructed his fleet for War of 1812 (1).

Pine Grove Furnace S.P.—scenic area, including stack of old iron furnace; near Shippensburg (47).

Pymatuning S.P.—almost 27 sq. mi. of reservoir formed by damming the Shenango River; near Jamestown (10).

Raccoon Creek S.P.—a preserve of scenic landscape in the coal-mining country west of Pittsburgh (24).

Ricketts Glen S.P.—more than 25 waterfalls in an area of natural beauty; Luzerne County (19).

Roosevelt H.M.—along the Easton to Bristol section of the Delaware Canal, early state waterway built in period 1827–32 (34).

Valley Forge H.M.—original and restored units of winter quarters of Washington's Continental Army; located on Schuylkill River near Philadelphia (43).

Washington Crossing H.M.—site of Washington's surprise move across the Delaware, Dec. 25, 1776 (34).

Worlds End S.P.—high mountains appear to close the valley from the rest of the world; near Forksville (13).

*Numbers in parentheses are keyed to map.
†There are 57 state parks and state historical monuments; 28 are listed.
‡S.P. refers to state park; H.M. to state historical monument.

Pennsylvania Fact Summary

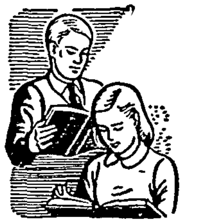
STATE FORESTS*†

Bald Eagle (Centre, Clinton, Snyder, Union Counties)—131,681 acres (22).
Elk (Cameron, Elk, Potter Cos.)—181,154 a. (11).
Moshannon (Centre, Clearfield, Elk Cos.)—162,198 a. (20).
Sproul (Centre, Clinton Cos.)—219,922 a. (17).
Susquehannock (McKean, Clinton, Potter Cos.)—293,486 a. (9).
Tiadaghton (Clinton, Lycoming Cos.)—176,113 a. (18).
Tioga (Bradford, Tioga Cos.)—105,750 a. (6).

NATIONAL FOREST*

Allegheny—721,697 a.; headquarters, Warren (5).

EDUCATION



Public Schools: Elementary, 5,989; secondary, 1,342; joint school organizations, 401. Compulsory school age, 8 through 16; but law effective at once for children entering between 5 yrs. 7 mos. and 8. State Council of Education consists of supt. of public instruction, appointed by governor for 4-yr. term, and 9 other members appointed for 6-yr. terms. County supts. elected for 4-yr. terms by a convention of school directors in each county. City school board members elected by popular vote except in Pittsburgh and Philadelphia, where they are appointed. City, borough, and township supts. appointed by boards of school directors in their respective districts.

Private and Parochial Schools: 1,400.

Colleges and Universities (accredited): Colleges, 74. Junior colleges, 11. State-supported schools include Pennsylvania State Univ., at State College, with its 6 undergraduate centers; 14 state teachers colleges located throughout the state. Other state-aided schools include Hahnemann Medical College, Jefferson Medical College, Moore Institute of Art, Science, and Industry, Philadelphia Museum School of Art, Temple Univ., Univ. of Pennsylvania, Woman's Medical College, all in Philadelphia; Lincoln Univ., at Lincoln University; Univ. of Pittsburgh, Pittsburgh; National Agricultural College, Farm School.

Special State Schools: Berean Manual Training and Industrial School, Franklin Institute, Philadelphia Commercial Museum, all in Philadelphia; Downington Industrial and Agricultural School, Downington; Johnson School and Pennsylvania State Oral School for the Deaf, both in Scranton; Scotland School for Veterans' Children, Scotland; Thaddeus Stevens Trade School, Lancaster; Williamson Free School of Mechanical Trades, Williamson School.

Libraries: City and town public libraries, 350; independent county library systems, 14 (excluding Philadelphia); 14 counties contract for service with city libraries. State library responsible for aid in developing library service. Noted special libraries: German Society of Pennsylvania, Commercial Museum, Friends Free Library, Academy of Natural Sciences of Philadelphia Library, American Philosophical Society Library, Historical Society of Pennsylvania Library, all in Philadelphia; Bucks County Historical Society, Doylestown.

Outstanding Museums: Pennsylvania State Museum, Harrisburg; Philadelphia Museum of Art, Academy of Natural Sciences, Franklin Institute, Univ. Museum, all at Philadelphia; Carnegie Museum, Pittsburgh.

*Numbers in parentheses are keyed to map on preceding page.
†There are 23 state forests; the 7 largest are listed.

CORRECTIONAL AND PENAL INSTITUTIONS

Pa. Training School, Morganza; Pa. Institution for Defective Delinquents, Huntingdon; Pa. Industrial School, Camp Hill; State Industrial Home for Women, Muncy; Eastern State Penitentiary, Philadelphia; State Penitentiaries at Graterford and Rockview; Western State Penitentiary, Pittsburgh.

LARGEST CITIES (1950 census)

Philadelphia (2,071,605): Atlantic port on Delaware and Schuylkill rivers; shipbuilding; metal, textile, food, and chemical industries; printing and publishing.
Pittsburgh (676,806): industrial city at point where Allegheny and Monongahela rivers meet to form Ohio River; steel mills; coal, aluminum, glass industries.
Erie (130,803): port on Lake Erie; manufactures electrical equipment, and steel, rubber, and paper products.
Scranton (125,536): city of varied industries in heart of anthracite region; lace mills; nylon and rayon textiles.
Reading (109,320): railroad shops; textile machinery; hosiery and hats; foundry products; hardware.
Allentown (106,756): industrial center of Lehigh Valley.
Harrisburg (89,544): state capital, on Susquehanna River; produces iron, steel, and dairy products, clothing.
Altoona (77,177): large railroad shops; silk, clothing, lumber, shoes, bearings, patterns, radiators, auto parts.
Wilkes-Barre (76,826): in anthracite-mining district; manufactures textile, metal, and food products.
Bethlehem (66,340): iron and steel; textiles; chemicals.
Chester (66,039): port city on Delaware River; locomotives; petroleum and steel products; ships.
Lancaster (63,774): linoleum, watches, television tubes.
Johnstown (63,232): coal shipping; steel mills.

THE PEOPLE BUILD THEIR STATE

1609—Henry Hudson explores lower Delaware River and Bay; establishes Dutch claim to surrounding territory.
1614—Dutch Captain Cornelis Hendricksen sails up Delaware River to Schuylkill River.
1615—Étienne Brulé, working for France, explores entire Susquehanna River valley.
1638—Swedes build Fort Christina on site of present Wilmington, Del.; they buy from the Indians the land along the west bank of the Delaware River, naming the territory, New Sweden; first governor of the colony is Peter Minuit, a Dutchman.
1643—Johan Printz arrives as governor of New Sweden; establishes first local government and first courts in Pennsylvania area; builds forts on Tinicum Island, at Upland (Chester), and at mouth of Schuylkill River.
1651—Peter Stuyvesant builds Dutch Fort Casimir on site of New Castle, Del., with aim of driving Swedes from area; Swedes seize the fort, 1654.
1655—Dutch under Stuyvesant recapture Fort Casimir; drive Swedes from New Sweden.
1664—English under Col. Richard Nicolls establish rule over Dutch colony of New Netherland; region along Delaware River becomes part of English Province of New York under Duke of York.
1681—Charles II of England grants William Penn most of present Pennsylvania; Penn sends his cousin, William Markham, to take over the colony.
1682—Duke of York leases to Penn "Three Lower Counties" (present state of Delaware). Penn wants to

call his colony New Wales but is overruled by Charles II, who names it Pennsylvania. Penn arrives at New Castle (Delaware) in ship *Welcome*, October 27. Penn's 'Frame of Government' published; it emphasizes religious liberty and representative government. Site of present Philadelphia selected; city becomes capital of colony, 1685.

1683—By the Great Treaty at Shackamaxon (now Kensington district in Philadelphia), Indians grant Penn land in southeastern Pennsylvania. First colonial assembly meets at Philadelphia; passes Act of Settlement accepting Penn's Frame of Government with some modifications. German Quakers and Mennonites led by Francis Pastorius found Germantown (now district in Philadelphia). First glass factory built at Frankford (also part of present Philadelphia).

1689—Friends' Public Grammar School (now William Penn Charter School) opens in Philadelphia.

1690—First American paper mill built in Philadelphia.

1692—Penn arrested in England on charges of disloyalty; is deprived of governing rights in Pennsylvania; rule of colony temporarily passes to governor of New York; Penn's rights restored, 1694.

1701—Penn grants Charter of Privileges to the colony. Philadelphia chartered as a city.

1704—"Three Lower Counties" (present Delaware) secede from Provincial Assembly of Pennsylvania.

1708—Penn mortgages province; agrees to sell area to Queen Anne, but his death (1718) prevents the sale; his heirs control colony until 1776.

1716—First known iron forge in Pennsylvania built near site of Pottstown by Thomas Rutter.

1719—*American Weekly Mercury*, published in Philadelphia, is first newspaper in Pennsylvania.

1732—Benjamin Franklin issues first number of 'Poor Richard's Almanack'.

1735—Johann Conrad Beissel establishes Ephrata, a religious community, near present Lancaster.

1737—Delaware Indians cede much of their western lands in the "Walking Purchase" (as far as a man could walk in three days).

1740—Charity school opens in Philadelphia; is forerunner of University of Pennsylvania (chartered 1791).

1751—Pennsylvania Hospital, oldest in what is now the U. S., founded in Philadelphia by Benjamin Franklin and Thomas Bond.

1754—Ohio Company of Virginia builds fort at forks of Ohio River (junction of Allegheny and Monongahela rivers); French capture it, name it Fort Duquesne; Virginia troops, led by George Washington, are defeated at Great Meadows; this clash is start of French and Indian War.

1755—French and Indians defeat British under Gen. Edward Braddock in battle on Monongahela River, July 9; Indians terrorize much of Pennsylvania, massacring colonists and destroying settlements.

1758—Colonists make peace with Indians at Easton; French evacuate Fort Duquesne and destroy it.

1759—Colonial soldiers build Fort Pitt near former Fort Duquesne. First bituminous coal discovered near present Pittsburgh and near Brownsville.

1762—Anthracite discovered in Wyoming Valley.

1763—Pontiac War breaks out; Indians attack settlers in western Pennsylvania; war ends, 1764. Charles Mason and Jeremiah Dixon begin survey of Mason and Dixon's Line, boundary between Pennsylvania and Maryland; survey concluded, 1767.

1768—Treaty of Fort Stanwix settles outstanding Indian problems; "New Purchase," land in western Pennsylvania obtained by treaty, opened to settlement.

1769—In Wyoming Valley, Pennsylvanians clash with settlers from Connecticut over boundary dispute in "Pennamite-Yankee War."

1774—First Continental Congress meets in Philadelphia; passes measures to cut off trade with British.

1775—Second Continental Congress meets in Philadelphia. Committee of Safety controls Pennsylvania.

1776—Declaration of Independence signed at Philadelphia, July 4; State House bell proclaims "liberty throughout the land." Thomas Paine's 'Common Sense' published in Philadelphia. Benjamin Franklin presides over convention which adopts constitution making Pennsylvania an independent state; Delaware breaks from Pennsylvania, forming independent state. Philadelphia threatened by British advance; Continental Congress transfers to Baltimore; Washington saves city by defeating British at Trenton. First American flag made, tradition says, by Betsy Ross of Philadelphia.

1777—Americans defeated by British at Brandywine; British occupy Philadelphia; Congress moves to York where it draws up Articles of Confederation. Washington defeated at Germantown; goes into winter quarters at Valley Forge.

1778—British leave Philadelphia. Indians and Tories massacre settlers in Wyoming Valley. Congress returns to Philadelphia, July 2.

1780—Pennsylvania is first state to abolish slavery.

1781—Bank of North America, first bank in United States, chartered by Continental Congress; begins operations in Philadelphia, 1782.

1782—Congress settles Wyoming Valley controversy against Connecticut in favor of Pennsylvania.

1784—Pennsylvania and Virginia accept Mason and Dixon's Line of 1767 as their common boundary.

1787—Constitutional Convention meets in Philadelphia in May; drafts U. S. Constitution; Pennsylvania is second state to ratify it, December 12.

1789—New York accepts 42d parallel as New York-Pennsylvania boundary, except "Erie triangle."

1790—New state constitution adopted. Philadelphia becomes capital of U. S. First iron furnaces west of Alleghenies opened in Fayette County.

1791—Bank of the United States opens in Philadelphia.

1792—Pennsylvania buys "Erie triangle" from U. S. government, achieving its present state boundaries. U. S. Mint established in Philadelphia.

1793—Bank of Pennsylvania chartered.

1794—Farmers of western Pennsylvania challenge authority of federal government in Whiskey Rebellion; federal troops quell revolt.

1799—State capital moved from Philadelphia to Lancaster.

1800—National capital moved to Washington, D. C.

1811—*New Orleans*, first steamboat on Ohio and Mississippi rivers, is launched at Pittsburgh.

1812—Harrisburg becomes state capital.

1829—First locomotive in United States runs between Carbondale and Honesdale.

1834—Philadelphia-Columbian Railroad (forerunner of Pennsylvania Railroad) completed.

1846—First telegraph line across Alleghenies completed.

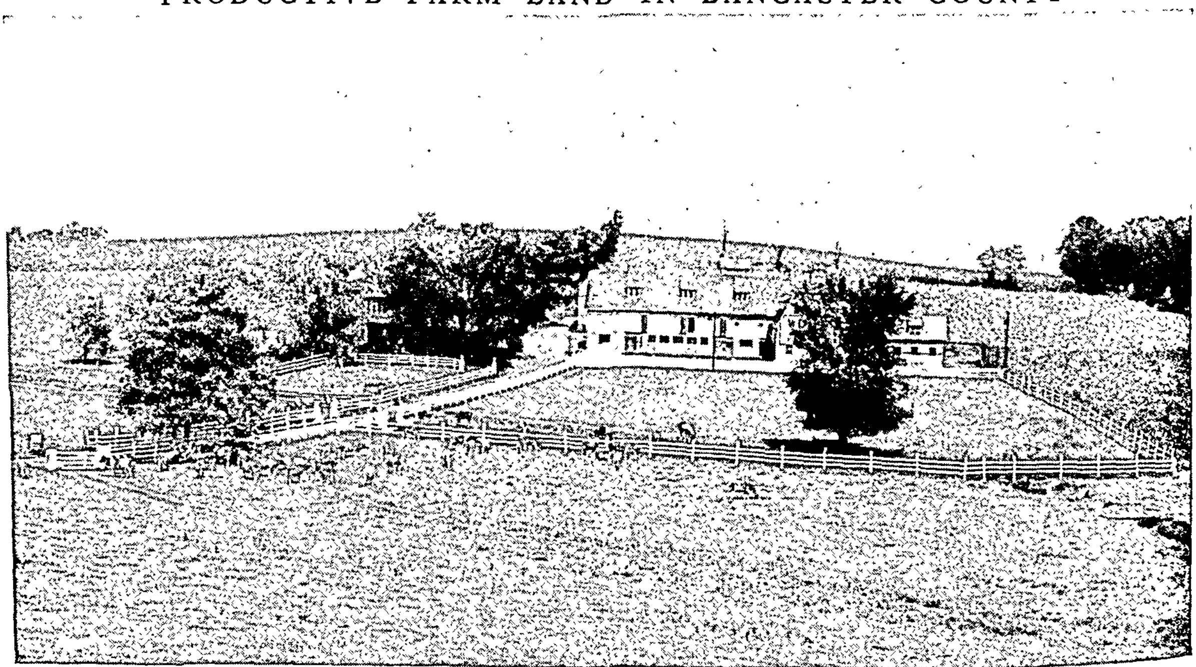
1849—Compulsory education act adopted.

1856—First national Republican party nominating convention meets in Philadelphia; names John C.

Pennsylvania Fact Summary

Frémont for presidency; Democratic candidate James Buchanan, born near Mercersburg, defeats Frémont to become 15th president of U. S.
1859—Oil well drilled near Titusville marks beginning of U. S. oil industry.
1862—Confederate troops invade Cumberland Valley.
1863—Confederate invasion of Pennsylvania defeated in battle of Gettysburg. Lincoln delivers Gettysburg Address at dedication of national cemetery.
1864—Invading Confederate troops burn Chambersburg.
1868—Andrew Carnegie introduces first practical Bessemer steel process in U. S.; makes Pittsburgh and surrounding area the steel center of the world.
1873—Present state constitution framed; effective, 1874.
1876—Centennial Exposition at Philadelphia celebrates 100th anniversary of Declaration of Independence.
1887—Centennial of adoption of U. S. Constitution celebrated at Philadelphia.
1889—Johnstown destroyed by flood; about 2,200 killed.
1897—State Capitol burns, February 2; rebuilt, 1898.
1911—State primary adopted.
1920–21—KDKA of Pittsburgh becomes one of pioneer radio broadcasting stations in the world; receives telephone apparatus license Oct. 27, 1920; receives radio broadcast license Nov. 7, 1921.
1926—Philadelphia celebrates 150th anniversary of nation's independence; opens Delaware R. Bridge.
1936—Severe floods devastate many areas.
1940—Pennsylvania Turnpike, 160-mile toll expressway opened between Carlisle and Irwin; 100-mile Carlisle-Valley Forge section finished, 1950; 67-mile extension to Ohio dedicated, 1951; 32-mile Valley Forge-Delaware R. section, Delaware R. bridge, and 110-mile extension to north of Scranton in work, 1954.
1950—Blizzards paralyze western part of state.
1952—Huge steel plant near Morrisville begins operation. Delaware River Port Authority of Pennsylvania and New Jersey established.
1953—First general sales tax (1%) in state approved.
1954—Ohio River site 25 miles n. w. of Pittsburgh chosen for nation's 1st full-scale atomic power plant.

PRODUCTIVE FARM LAND IN LANCASTER COUNTY



In Pennsylvania's Lancaster County are some of the nation's most productive farms. The rich, rolling land yields a variety of crops, including corn, hay, tobacco, and small grains. Dairying accounts for a large percentage of the farm income. Big, roomy barns and neat farmyards are common in this area. The average size of the farms is about 60 acres.

INDEX TO THE MAP OF PENNSYLVANIA

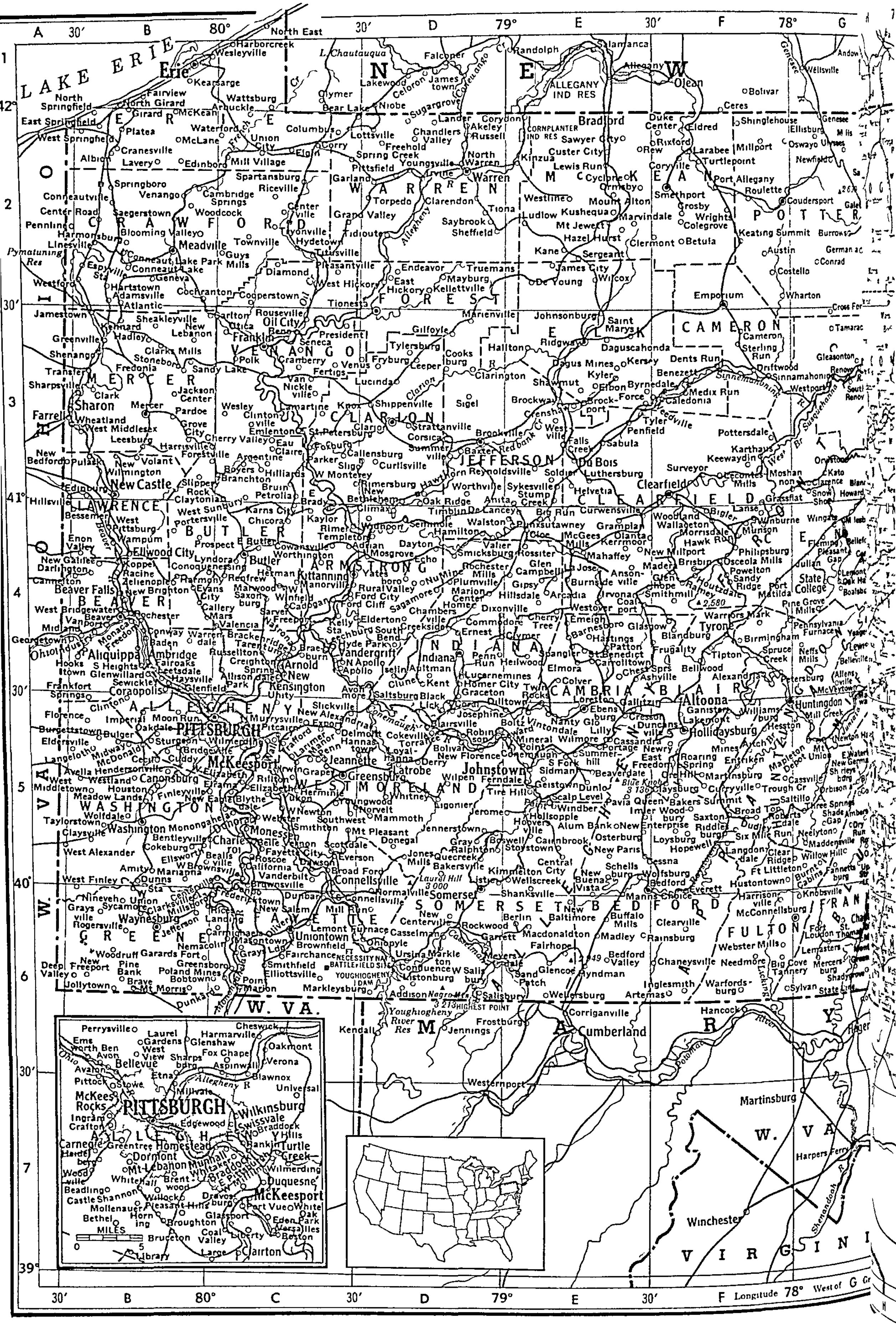
COUNTIES

Adams	44,197	H 6
Allegheny	1,515,237	B 5
Armstrong	80,842	D 4
Beaver	175,192	B 4
Bedford	40,775	E 6
Berks	255,740	K 5
Blair	139,514	F 4
Bradford	51,722	J 2
Bucks	144,620	M 5
Butler	97,320	C 4
Cambria	209,541	E 4
Cameron	7,023	F 3
Carbon	57,558	L 4
Centre	65,922	G 4
Chester	159,141	L 6
Clarion	38,344	D 3
Clearfield	85,957	F 3
Clinton	36,532	G 3
Columbia	53,460	K 3
Crawford	78,948	B 2
Cumberland	94,457	H 5
Dauphin	197,784	J 5
Delaware	414,234	M 6
Elk	34,503	E 3
Erie	219,388	B 2
Fayette	189,899	C 6
Forest	4,944	D 2
Franklin	75,927	G 6
Fulton	10,387	F 6
Greene	45,394	B 6
Huntingdon	40,872	F 5
Indiana	77,106	D 4
Jefferson	49,147	D 3
Juniata	15,243	H 4
Lackawanna	257,396	L 3
Lancaster	234,717	K 5
Lawrence	105,120	B 4
Lebanon	81,683	K 5
Lehigh	198,207	L 4
Luzerne	392,241	L 3
Lycoming	101,249	H 3
McKean	56,607	E 2
Mercer	111,954	B 3
Mifflin	43,691	G 4
Monroe	33,773	M 3
Montgomery	353,068	M 5
Montour	16,001	J 3
Northampton	185,243	M 4
Northumberland	117,115	J 4
Perry	24,782	H 5
Philadelphia	2,071,605	N 6
Pike	8,425	M 3
Potter	16,810	G 2
Schuylkill	200,577	K 4
Snyder	22,912	H 4
Somerset	81,813	D 6
Sullivan	6,745	J 3
Susquehanna	31,970	L 2
Tioga	35,474	H 2
Union	23,150	H 4
Venango	65,328	C 3
Warren	42,698	D 2
Washington	209,628	B 5
Wayne	28,478	M 2
Westmoreland	313,179	D 5
Wyoming	16,766	K 2
York	202,737	J 6

PENNSYLVANIA

CITIES AND TOWNS

Aaronsburg	350	H 4
Abbottstown	538	J 6
Adamsburg	238	*C 5
Adamstown	1,020	K 5
Adamsville	200	B 2
Addison	237	D 6
Adrian	130	D 4
Airville	125	K 6
Aitch	219	F 5
Akeley	50	D 2
Akron	1,028	K 5
Alba	190	J 2
Albion	1,729	B 2
Albrightsville	150	L 3
Alburtis	979	L 5
Aldan	3,430	M 7
Aldenville	100	M 2
Alexandria	443	F 4
Aliquippa	26,132	B 4
Allen	395	H 5
Allenport	923	*C 5
Allensville	300	G 4
Allentown	106,756	L 4
Allenwood	367	H 3
Allison Park	2,000	C 4
Altoona	77,177	F 4
Alum Bank	342	E 5
Amberson		G 5
Ambler	4,565	M 5
Ambridge	16,429	B 4
Amity	240	B 5
Andalusia	1,800	N 5
Anita	350	D 3
Annville	3,564	J 5
Ansonville	158	E 4
Antes Fort	300	H 3
Antrim	300	H 2
Apollo	3,015	D 4
Applewold	500	*C 4
Ararat	72	L 2
Arbuckle	25	C 1
Arcadia	500	E 4
Archbald	6,304	M 2
Ardmore	20,000	M 6
Arendtsville	409	H 6
Argentine	150	C 3
Armagh	176	*E 4
Arnold	10,263	C 4
Arnot	300	H 2
Arona	482	*C 5
Artemas	19	E 6
Ashland	6,192	K 4
Ashley	5,243	L 3
Ashville	441	F 4
Aspers	220	H 6
Aspinwall	4,084	C 6
Atglen	668	K 6
Athens	4,430	K 2
Athol	200	L 5
Atlantic	157	B 3
Atlas	3,090	K 4
Atwood	110	*D 4
Auburn	994	K 4
Aultman	600	D 4
Austin	804	F 2
Avalon	6,463	B 6
Avella	1,356	B 5
Avis	1,193	H 3
Avoca	4,040	L 3
Avondale	941	L 6
Avonmore	1,367	C 4
Baden	3,732	B 4
Bainbridge	500	J 5
Bakers Summit	70	F 5
Bakersville	170	D 5
Bala-Cynwyd	7,500	N 6
Bally	753	L 5
Bangor	6,050	M 4
Barnesboro	3,442	E 4
Barto	151	L 5
Bartonsville	150	M 4
Bath	1,824	M 4
Baxter	87	D 3
Beach Haven	500	K 3
Beach Lake	250	M 2
Beadling	350	B 7
Beallsville	598	C 5
Bear Creek	150	L 3
Bear Lake	239	C 1
Beaver	6,360	B 4
Beaver Falls	17,375	B 4
Beaver Meadows	1,723	L 4
Beaver Springs	750	H 4
Beaverdale	2,200	E 5
Beavertown	700	H 4
Bechtelsville	603	*L 5
Bedford	3,521	F 5
Bedford Valley	300	E 6
Bedminster	500	M 5
Beech Creek	574	G 3
Belle Vernon	2,271	C 5
Bellefonte	5,651	G 4
Belleville	1,304	G 4
Bellevue	11,604	B 6
Bellwood	2,559	F 4
Ben Avon	2,465	B 6
Ben Avon Heights	394	*B 5
Bendersville	409	H 6
Benezett	400	F 3
Benson (Hollsopple)	377	E 5
Bentleyville	3,295	B 5
Benton	890	K 3
Berlin	1,507	E 6
Bermudian	50	J 5
Bernharts	760	K 5
Bernville	363	K 5
Berrysburg	386	J 4
Berwick	14,010	K 3
Berwyn	3,000	L 5
Bessemer	1,461	B 4
Bethany	148	M 2
Bethel	500	K 5
Bethel	11,324	B 7
Bethlehem	66,340	M 4
Betula	90	F 2
Big Cove Tannery	25	F 6
Big Run	896	E 4
Bigler	500	F 4
Biglerville	870	H 6
Birchardville	35	L 2
Birdsboro	3,158	L 5
Birmingham	178	F 4
Black Lick	1,000	D 4
Blain	315	H 5
Blairs Mills	150	G 5
Blairsville	5,000	D 5
Blakely	6,828	*L 3
Blakeslee	50	L 3
Blanchard	550	G 3
Blandburg	1,200	F 4
Blawnox	2,165	C 6
Bloomfield (New Bloomfield)	1,098	H 5
Blooming Grove	113	M 3
Blooming Valley	256	B 2
Bloomsburg	10,633	J 3
Blossburg	1,954	H 2
Blue Ridge Summit	650	G 6
Blythedale	890	C 5
Boalsburg	500	G 4
Bobtown	1,553	B 6
Bodines	110	H 3
Boiling Springs	900	H 5
Bolivar	828	D 5
Boltz	250	E 5
Boothwyn	4,500	L 7
Boston	1,700	C 7
Boswell	1,679	E 5
Bowmansdale	200	J 5
Bowmanstown	878	L 4
Bowmansville	350	L 5
Boyers	800	C 3
Boyertown	4,074	L 5
Brackenridge	6,178	C 4
Brackney	75	K 2
Braddock	16,488	C 7
Braddock Hills	1,965	C 7
Bradford	17,354	E 2
Bradfordwoods	458	*B 4
Braeburn	800	C 4
Branch Dale	1,500	K 4
Branchton	130	C 3
Brave	200	B 6
Brentwood	12,535	B 7
Briar Creek	348	K 3
Brickerville	150	K 5
Bridgeport	5,827	M 5
Bridgeville	5,650	B 5
Bridgewater (W. Bridgewater)	1,316	B 4
Brisbin	463	F 4
Bristol	12,710	N 5
Broad Ford	112	C 5
Broad Top	483	F 5
Brockport	450	E 3
Brockway	2,650	E 3
Brodbecks	50	J 6
Brodheadsville	550	M 4
Brogueville	55	J 6
Brookhaven	1,042	M 7
Brooklyn	500	L 2
Brookville	4,274	D 3
Broomall	6,000	M 6
Broughton	2,500	B 7
Brownfield		C 6
Brownstown	700	K 5
Brownstown	1,508	*E 5
Brownsville	7,643	C 5
Bruceton	250	B 7
Bruin	717	C 3
Bryn Athyn	913	M 5
Bryn Mawr	12,000	M 5
Bucksville	200	M 5
Buffalo Mills	105	E 6
Bugler	800	B 5
Burgettstown	2,379	A 5
Burlington	148	J 2
Burnham	2,954	H 4
Burnside	400	E 4
Burnt Cabins	125	G 5
Burrows	15	G 2
Bushkill	500	M 3
Butler	23,482	C 4
Byrnedale	500	E 3
Cadogan	727	C 4
Cairnbrook	1,504	E 5
Caledonia	300	F 3
California	2,831	C 5
Callensburg	261	D 3
Callery	407	C 4
Cambra	100	K 3
Cambridge Sprs.	2,246	C 2
Cameron	114	F 3
Cammal	120	H 3
Camp Hill	5,934	H 5
Camptown	300	K 2
Canadensis	400	M 3
Cannelton	100	A 4
Canonsburg	12,072	B 5
Canton	2,118	J 2
Carbondale	16,296	L 2
Carlisle	16,812	H 5
Carlton	50	C 3
Carmichaels	895	C 6
Carnegie	12,105	B 7
Carrolltown	1,452	E 4
Cashtown	270	H 6
Cassandra	381	E 5
Casselman	130	D 6
Cassville	158	G 5
Castle Shannon	5,459	B 7
Catasauqua	4,923	M 4
Catawissa	2,000	K 4
Cecil	1,200	B 5
Cedar Run	62	H 2
Center Moreland	100	K 3
Center Road	35	A 2
Centerport	226	*K 5
Centerville	245	C 2
Centerville	5,845	B 5
Central City	1,935	E 5
Centralia	1,986	K 4
Centre Hall	834	G 4
Cessna	50	F 5
Chalfant	1,381	*C 7
Chalfont	828	M 5
Chambersburg	17,212	G 6
Chambersville	300	D 4
Chandlers Valley	170	D 2
Chaneysville	80	F 6
Chapman	285	*M 4
Charleroi	9,872	C 5
Cheltenham	†22,854	M 5
Cherry Tree	517	E 4
Cherry Valley	94	C 3
Chest Springs	232	E 4
Chester	66,039	L 7
Chester Heights	474	L 7
Chester Hill	954	*F 4
Cheswick	1,534	C 6
Cheyney	289	M 6
Chicora	1,172	C 4
Choconut	50	K 2
Christiana	1,043	K 6
Churchill	1,733	*C 7
Churchtown	250	L 5
Clairton	19,652	C 7
Clarence	1,700	G 3
Clarendon	748	D 2
Clarington	125	D 3
Clarion	4,409	D 3
Clark	345	B 3
Clarks Green	824	*L 3
Clarks Mills	100	B 3
Clarks Summit	2,940	L 3
Clarksville	428	B 6
Clarksville (Clark)	345	B 3
Claysburg	1,355	F 5
Claysville	963	B 5
Claytonia	50	B 3
Clear Ridge	31	F 5
Clearfield	9,357	F 3
Clearville	200	F 6
Cleona	1,483	*K 5
Clermont	175	E 2
Clifford	300	L 2
Clifton Heights	7,549	M 7
Climax	300	D 4
Clinton	575	B 5
Clintondale	120	H 3
Clintonville	307	C 3
Cloe	275	E 4
Clune	500	D 4
Clymer	2,500	E 4
Coal Center	584	*C 5
Coal Valley	700	C 7
Coaldale	5,318	L 4
Coaldale	231	*F 5
Coalmont	207	*F 5
Coalport	1,052	E 4
Coatesville	13,826	L 5
Coburn	280	H 4
Cochranton	1,092	B 2
Cochranville	350	L 6
Cocolamus		H 4
Codorus	449	J 6
Cogan Station	39	H 3
Cokeburg	1,170	B 5
Cokeville	600	D 5
Colegrove	50	F 2
Collegeville	1,900	M 5
Colley	100	K 2
Collingdale	8,443	N 7
Colmar	600	M 5
Columbia	11,993	K 5
Columbus		C 2
Colver	1,708	E 4
Colwyn	2,143	*M 7
Commodore	450	D 4
Concord	190	G 5
Concordville	126	M 6
Conemaugh	5,000	E 5
Conestoga	480	K 6
Confluence	1,037	D 6
Conneaut Lake	676	B 2
Conneaut L. Park	225	B 2
Conneautville	1,177	A 2
Connellsville	13,293	D 5
Conoquenessing	441	B 4
Conrad	15	G 2
Conshohocken	10,922	M 5
Conway	1,570	B 4
Conyngham	935	K 3
Cooksburg	50	D 3
Coopersburg	1,462	M 5
Cooperstown	271	C 2
Coplay	2,994	L 4
Coral	675	D 5
Coraopolis	10,498	B 4
Cornwall	1,760	K 5
Corry	7,911	C 2
Corsica	421	D 3
Corydon	250	D 2
Coryville	320	F 2
Costello	100	G 2
Coudersport	3,210	G 2
Courtdale	982	*L 3
Covington	725	J 2
Cowan	105	H 4
Cowanesque	200	H 2
Cowansville	306	C 4
Crafton	8,066	B 7
Cranberry	450	C 3
Cranesville	602	B 2
Creekside	525	D 4
Creighton		C 4
Crenshaw		E 3
Cresco	150	M 3
Cresson	2,569	E 5
Cressona	1,758	K 4
Crosby	400	F 2
Cross Fork	85	G 3
Cross Roads	178	*J 6
Crum Lynne	3,500	M 7
Cuddy	2,500	B 5
Curllsville	156	D 3
Curryville	150	F 5
Curwensville	3,332	E 4
Custer City	500	E 2
Cyclone	700	E 2
Dagus Mines	500	E 3
Daguscahonda	190	E 3
Daisytown	442	*E 5
Dale	3,310	*E 5
Dallas	1,674	K 3
Dallastown	3,304	J 6
Dalmatia	517	J 4
Dalton	1,109	L 2
Damascus	300	M 2
Danielsville		M 4
Danville	6,994	J 4
Darby	13,154	N 7
Darling	50	L 7
Darlington	354	A 4
Dauphin	667	J 5
Dawson	723	C 5
Dayton	828	D 4
De Lancey	300	D 4
De Young	85	E 2
Deemston	775	*B 5
Deep Valley	95	A 6
Deer Lake	174	*L 4
Delano	950	K 4
Delaware Water Gap	734	N 4
Delmont	695	D 5
Delta	840	K 6
Denbo	1,300	C 6
Dents Run	30	F 3
Denver	1,658	K 5
Derry	3,752	D 5
Devault	300	L 5
Dewart	350	J 3
Diamond	100	C 2
Dickinson	250	H 5
Dickson City	8,948	L 3
Dillsburg	1,146	J 5
Dilltown	200	E 5
Dimock	100	L 2
Dingmans Ferry	525	N 3
Dixonville	1,050	D 4
Donegal	198	D 5
Donora	12,186	C 5
Dormont	13,405	B 7
Douglassville	800	L 5
Dover	809	J 6
Downingtown	4,948	L 5
Doylestown	5,262	M 5
Dravosburg	3,786	C 7
Drexel Hill	40,000	M 6
Drifton	950	L 3
Driftwood	289	F 3
Drums	450	K 3
Dry Run	200	G 5
Du Bois	11,497	E 3
Dublin	400	M 5
Duboistown	1,140	H 3
Dudley	350	F 5
Duke Center	1,200	F 2
Dunbar	1,363	C 6
Duncannon	1,852	H 5
Duncansville	1,391	F 5
Dunkard		B 6
Dunlevy	379	*C 5
Dunlo	2,200	E 5
Dunmore	20,305	L 3
Dunns Station	45	B 5
Dupont	4,107	*L 3
Duquesne	17,620	C 7
Duryea	6,655	L 3
Dushore	759	K 2
Eagles Mere	157	J 3
East Bangor	988	M 4
East Berlin	913	J 6
East Brady	1,400	C 3
East Butler	758	C 4
East Conemaugh	4,101	*E 5
East Freedom	325	E 5
East Greenville	1,945	L 5
East Hickory	232	D 2
East Lansdowne	3,527	*M 7
E. Mauch Chunk	3,132	*L 4
East McKeesport	3,171	*C 5
East Petersburg	1,268	K 5
East Pittsburgh	5,259	C 7
East Prospect	500	J 6
East Rochester	985	*B 4
East Side	286	L 3
East Smithfield	250	J 2
East Springfield	499	A 2
East Stroudsburg	7,274	M 4
East Vandergrift	1,665	*C 4
East Washington	2,304	*B 5
East Waterford	185	G 5
Easton	35,632	M 4
Eastvale	533	*B 4
Eau Claire	403	C 3
Ebensburg	4,086	E 5
Echo	200	D 4
Eckley	650	L 3
Eddington	2,000	N 5
Eddystone	3,014	M 7
Eden Park	1,531	C 7
Edgewood	5,292	B 7
Edgeworth	1,466	*B 4
Edinboro	1,567	B 2
Edinburg	500	B 3
Edison	450	M 5
Edwardsville	6,686	*L 3
Effort	300	M 4
Elbon	150	E 3
Elco	596	*C 5
Eldersville	250	A 5
Elderton	336	D 4
Eldred	1,199	F 2
Eldredsville	20	J 2
Elgin	202	C 2
Elimsport	75	H 3
Elizabeth	2,615	C 5
Elizabethtown	5,083	J 5
Elizabethville	1,506	J 5
Elkins Park	12,000	M 5
Elkland	2,326	H 1
Elliottsburg	100	H 5
Elliottsville	120	C 6
Ellisburg	100	G 2
Ellport	1,122	*B 4
Ellsworth	1,670	B 5
Ellwood City	12,945	B 4
Elmhurst	800	M 3
Elmora	1,850	E 4
Elrama	1,675	C 5
Elverson	370	L 5
Elwyn	1,800	L 7
Elysburg	700	K 4
Embreeville	48	L 6
Emeigh		E 4
Emigsville	650	J 5
Emlenton	945	C 3
Emmaus	7,780	M 4
Emporium	3,646	F 2
Emsworth	3,128	B 6
Endeavor	400	D 2
Enola	2,500	J 5
Enon Valley	392	B 4
Entriken	101	F 5
Ephrata	7,027	K 5
Equinunk	300	M 2
Erie	130,803	B 1
Ernest	1,170	D 4
Erwinna	150	N 5
Espy	700	K 4
Espyville Station	75	B 2
Essington	3,700	M 7
Esterly	900	L 5
Etna	6,750	B 6
Etters	558	J 5
Evans City	1,637	B 4
Evansburg (Evans City)	1,637	B 4
Evansville	100	L 5
Everett	2,297	F 5
Everson	1,520	C 5
Exeter	5,130	*L 3
Export	1,690	C 5
Factoryville	1,005	L 2
Fairchance	2,091	C 6
Fairdale	300	L 2
Fairfield	451	H 6
Fairhope	166	E 6
Fairmount Springs	50	K 3
Fairoaks	1,600	B 4
Fairview	697	B 1
Fairview	259	*C 4
Falls	315	L 3
Falls Creek	1,191	E 3
Fallsington	830	N 5
Fallston	511	*B 4
Fannettsburg	290	G 5
Farrell	13,644	A 3
Fawn Grove	397	J 6
Fayette City	1,404	C 5
Fayetteville	956	H 6
Felton	429	J 6
Ferndale	194	M 4
Ferndale	2,619	D 5
Fernwood	400	M 7
Fertigs	108	C 3
Finleyville	684	B 5
Fleetwood	2,338	L 5
Fleming	320	G 4
Flemington	1,446	G 3
Florence	150	A 5
Florin	1,319	J 5
Folcroft	1,909	M 7
Folsom	2,500	M 7
Force	500	E 3
Ford City	5,352	D 4
Ford Cliff	597	D 4
Forest City	3,122	L 2
Forest Hills	6,301	*C 5
Forestville	150	B 3
Forksville	145	J 3
Fort Littleton	117	F 5
Fort Loudon	500	G 6
Forty Fort	6,173	L 3
Fountain Hill	5,456	*M 4
Fox Chapel	1,721	C 6
Foxburg	422	C 3
Frackville	6,541	K 4
Frankfort Springs	149	A 4
Franklin	10,006	C 3
Franklin	1,833	*E 5
Franklintown	328	H 5
Fredericksburg	850	J 5
Fredericktown	1,000	C 6
Fredonia	588	B 3
Freeburg	506	H 4
Freedom	3,000	B 4
Freehold	120	D 2
Freeland	5,909	L 3
Freemansburg	1,739	M 4
Freeport	2,685	C 4
Friendsville	65	L 2
Frugality	63	F 4
Fryburg	300	D 3
Gaines	125	G 2
Galeton	1,646	G 2
Gallitzin	3,102	E 4
Ganister	253	F 5
Gap	850	L 6
Garards Fort	200	B 6
Garland	450	C 2
Garrett	761	D 6
Geistown	2,148	E 5



LAKE ERIE
North East
Erie
Harborcreek
Wesleyville
ERIE
CRAWFORD
WARREN
McKEAN
POTTER
CAMERON
ELK
FOREST
VENANGO
MERCER
LAWRENCE
BUTLER
CLARION
JEFFERSON
CLEARFIELD
CENTRE
ARMSTRONG
INDIANA
BEAVER
ALLEGHENY
WESTMORELAND
WASHINGTON
GREENE
FAYETTE
SOMERSET
BEDFORD
FULTON
CAMBRIA
BLAIR
HUNTINGDON
FRANKLIN
NEW YORK
OHIO
W. VA.
MARYLAND
VIRGINIA
L. Chautauqua
ALLEGANY IND RES
CORNPLANTER IND RES
Pymatuning Res
Youghiogheny River Res
Salamanca
Olean
Jamestown
Bradford
Warren
Meadville
Titusville
Oil City
Franklin
Sharon
New Castle
Butler
Kittanning
Indiana
Clearfield
Du Bois
Johnstown
Altoona
Hollidaysburg
Huntingdon
State College
Tyrone
Greensburg
Latrobe
PITTSBURGH
McKeesport
Washington
Waynesburg
Uniontown
Connellsville
Somerset
Bedford
Cumberland
Westernport
Frostburg
Hagerstown
Martinsburg
Winchester
Harpers Ferry
Emporium
Coudersport
Mount Davis 3 213 HIGHEST POINT
Allegheny R
Monongahela R
Youghiogheny R
Susquehanna R
Potomac R
Shenandoah R
Juniata R
Clarion R
A
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80°
79°
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30′
42°
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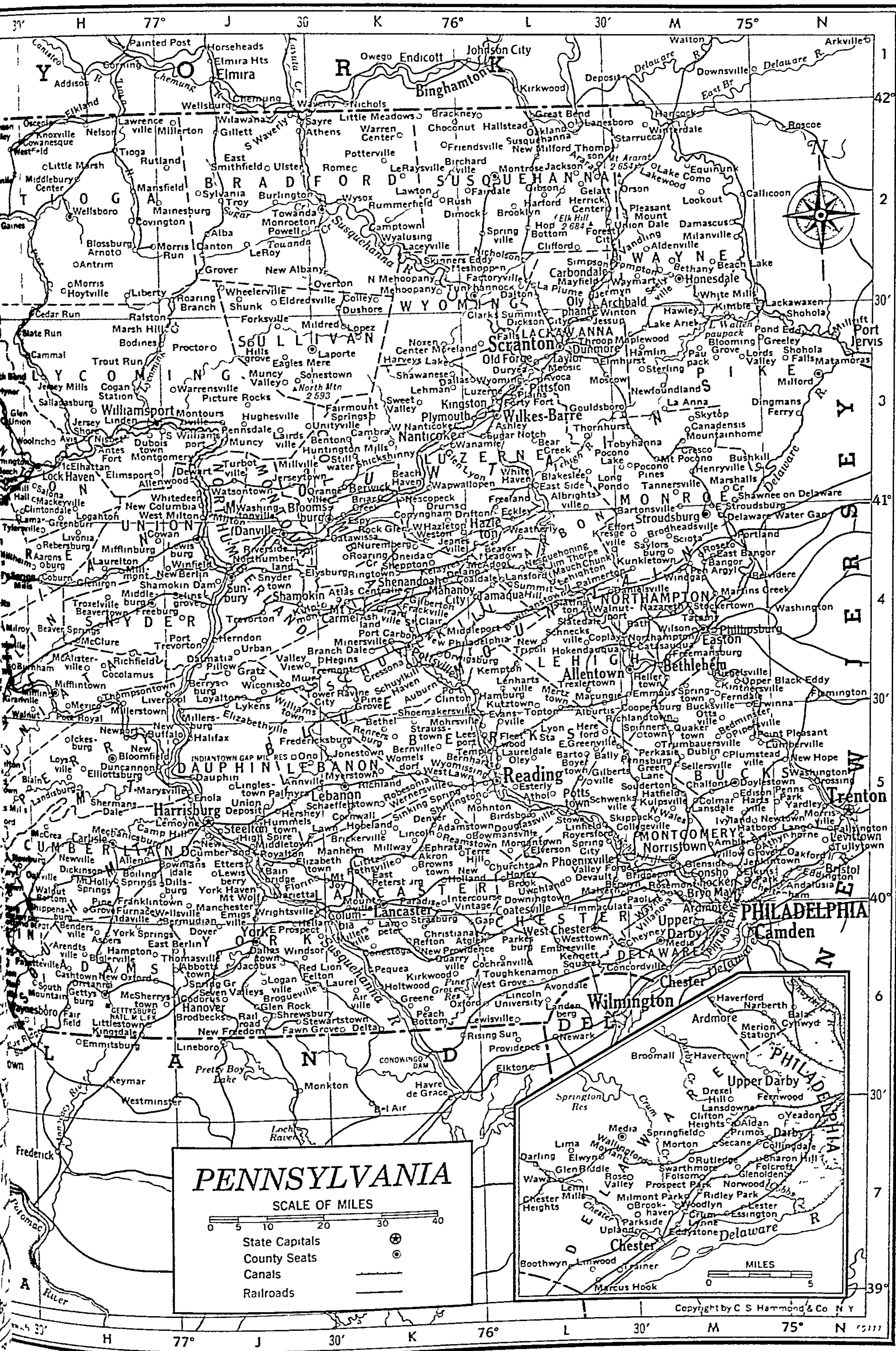
40°
39°
Longitude 78° West of Greenwich
PITTSBURGH
Bellevue
Homestead
McKeesport
Wilkinsburg
Duquesne
Clairton
MILES
0
5


PENNSYLVANIA
SCALE OF MILES
0 5 10 20 30 40
State Capitals
County Seats
Canals
Railroads
Copyright by C S Hammond & Co N Y
NEW YORK
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
WYOMING
SULLIVAN
LYCOMING
LACKAWANNA
PIKE
LUZERNE
MONROE
COLUMBIA
MONTOUR
NORTHUMBERLAND
UNION
SNYDER
CARBON
NORTHAMPTON
SCHUYLKILL
LEHIGH
DAUPHIN
LEBANON
BERKS
BUCKS
MONTGOMERY
CUMBERLAND
PERRY
JUNIATA
ADAMS
YORK
LANCASTER
CHESTER
DELAWARE
PHILADELPHIA
NEW JERSEY
MARYLAND
DEL
Elmira
Binghamton
Johnson City
Endicott
Scranton
Wilkes-Barre
Williamsport
Harrisburg
Reading
Allentown
Bethlehem
Easton
Lancaster
York
Lebanon
Pottsville
Hazleton
Norristown
West Chester
Chester
Wilmington
Trenton
Camden
Stroudsburg
Honesdale
Sunbury
Shamokin
Hanover
Gettysburg
Carlisle
Port Jervis
Delaware R.
Susquehanna R.
Upper Darby
Ardmore
Media
Haverford
Narberth
Swarthmore
Delaware R

PENNSYLVANIA — *Continued*

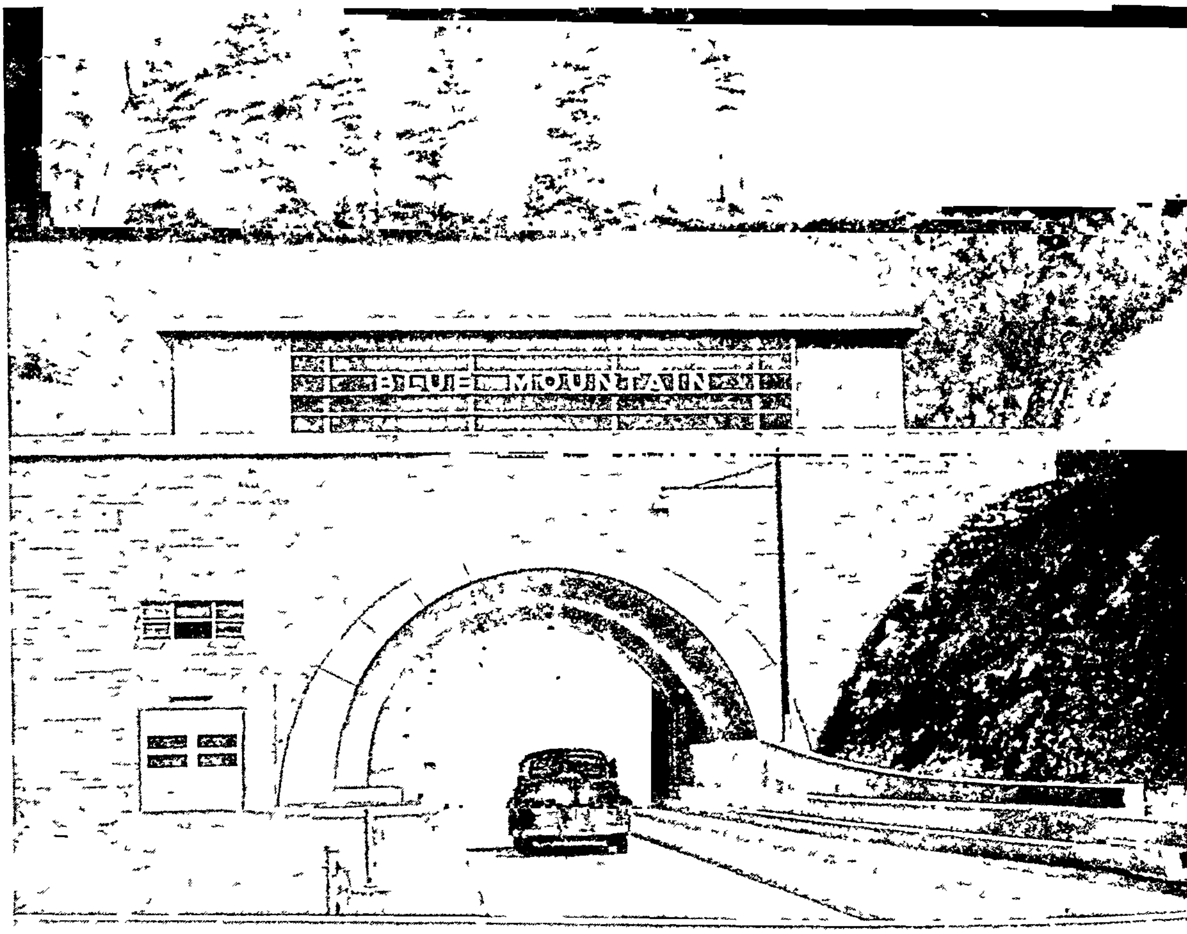
Gelatt	110	L 2
Genesee	600	G 2
Geneva	335	B 2
Georgetown	246	A 4
Germania	200	G 2
Gettysburg	7,046	H 6
Gibson	100	L 2
Gilberton	2,641	K 4
Gilbertsville	500	L 5
Gilfoyle	25	D 3
Gillett	200	J 2
Gipsy	300	E 4
Girard	2,141	B 2
Girardville	3,864	K 4
Glasgow	214	E 4
Glassport	8,707	C 7
Gleasonton	150	G 3
Glen Campbell	510	E 4
Glen Lyon	3,921	K 3
Glen Riddle	300	L 7
Glen Rock	1,477	J 6
Glen Union	19	G 3
Glencoe	80	E 6
Glendon	601	*M 4
Glenfield	870	B 4
Glenhope	199	F 4
Gleniron	250	H 4
Glenolden	6,450	M 7
Glenshaw	8,000	C 6
Glenside	8,000	M 5
Glenwillard	1,200	B 4
Goldsboro (Etters)	558	J 5
Gordon	1,039	*K 4
Gouldsboro	462	L 3
Graceton	500	D 4
Grampian	589	E 4
Grand Valley		D 2
Granville	2,157	G 4
Grapeville	1,563	C 5
Grassflat	1,000	F 3
Gratz	653	J 4
Gray	600	D 5
Grays Landing	450	C 6
Graysville	300	B 6
Great Bend	751	L 2
Greeley	590	N 3
Green Lane	550	M 5
Greenburr	125	H 4
Greencastle	2,661	G 6
Greene	75	K 6
Greensboro	651	B 6
Greensburg	16,923	D 5
Greentree	2,818	B 7
Greenville	9,210	B 3
Grove City	7,411	B 3
Grover	200	J 2
Guys Mills	300	C 2
Hadley	350	B 3
Halifax	822	J 5
Hallstead	1,445	L 2
Hallton	75	E 3
Hamburg	3,805	L 4
Hamilton	100	D 4
Hamlin	250	M 3
Hampton	200	H 6
Hannastown	800	D 5
Hanover	14,048	J 6
Harborcreek	500	C 1
Harford	185	L 2
Harmarville	3,000	C 6
Harmonsburg	350	B 2
Harmony	912	B 4
HARRISBURG	89,544	J 5
Harrison Valley	400	G 2
Harrisonville	23	F 6
Harrisville	780	B 3
Hartleton	240	*H 4
Hartstown	160	B 2
Hartsville		M 5
Harveys Lake	1,500	L 3
Hastings	1,846	E 4
Hatboro	4,788	M 5
Hatfield	1,624	M 5
Haverford	†39,641	M 6
Havertown	22,000	M 6
Hawk Run		F 4
Hawley	1,602	M 3
Hawthorn	666	D 3
Haysville	177	B 4
Hazel Hurst	600	E 2
Hazleton	35,491	L 4
Hegins		K 4
Heidelberg	2,250	B 7
Heilwood	1,000	E 4
Hellam	976	J 6
Hellertown	5,435	M 4
Helvetia	500	E 3
Hendersonville	600	B 5
Henryville	100	M 3
Hereford	225	L 5
Herman	700	C 4
Herminie	2,072	C 5
Herndon	677	J 4
Herrick Center	190	L 2
Hershey	4,500	J 5
Hesston	137	F 5
High Spire	2,799	J 5
Hilliards	230	C 3
Hillsdale	200	E 4
Hillsgrove	337	J 3
Hillsville		A 4
Hokendauqua	1,460	L 4
Hollidaysburg	6,483	F 5
Hollsopple	377	E 5
Holtwood	500	K 6
Home	82	D 4
Homer City	2,372	D 4
Homestead	10,046	B 7
Homewood	316	*B 4
Honesdale	5,662	M 2
Honey Brook	864	L 5
Hookstown	247	B 4
Hooversville	1,240	E 5
Hop Bottom	375	L 2
Hopeland	400	K 5
Hopewell	360	F 5
Horning	500	B 7
Houston	1,957	B 5
Houtzdale	1,306	F 4
Howard	754	G 3
Hoytville	13	H 2
Hughestown	1,888	*L 3
Hughesville	2,095	J 3
Hulmeville	860	*N 5
Hummelstown	3,789	J 5
Hunkers	404	*C 5
Huntingdon	7,330	G 5
Huntingdon Mills	300	K 3
Hustontown	200	F 5
Hyde Park	758	D 4
Hydetown	530	C 2
Hyndman	1,322	E 6
Hyner	300	G 3
Ickesburg	250	H 5
Idaville	325	H 5
Imler	175	E 5
Immaculata	400	L 6
Imperial	1,895	B 5
Indiana	11,743	D 4
Industry	468	B 4
Inglesmith	14	F 6
Ingram	4,236	B 7
Intercourse	550	K 5
Irvine	300	D 2
Irvona	915	E 4
Irwin	4,228	C 5
Iselin		D 4
Ivyland	358	M 5
Jackson	100	L 2
Jackson Center	266	B 3
Jacksonville	204	*D 4
Jacobus	706	J 6
James City	500	E 2
Jamestown	931	A 3
Jeanesville	500	K 4
Jeannette	16,172	C 5
Jeddo	262	*L 3
Jefferson	575	B 6
Jefferson (Codorus)	449	J 6
Jenkintown	5,130	M 5
Jennerstown	376	D 5
Jermyn	2,535	L 2
Jerome	1,960	D 5
Jersey Mills	90	H 3
Jersey Shore	5,595	H 3
Jerseytown	165	J 3
Jessup	6,650	L 3
Jim Thorpe	2,959	L 4
Johnsonburg	4,567	E 3
Johnstown	63,232	D 5
Jollytown	100	B 6
Jones Mills	150	D 5
Jonestown	853	K 5
Josephine	675	D 5
Julian	196	G 4
Kane	5,706	E 2
Karns City	508	C 4
Karthaus	575	F 3
Kato		G 3
Kaylor	300	C 4
Kearsarge	375	B 1
Keating Summit	70	F 2
Keewaydin	121	F 3
Kelayres	1,059	K 4
Kellettville	80	D 2
Kelly Station	81	C 4
Kempton		L 4
Kenhorst	2,551	*L 5
Kennard	175	B 3
Kennett Square	3,699	L 6
Kent	175	D 4
Kerrmoor	120	E 4
Kersey	500	E 3
Kimble	72	M 3
Kimmelton	156	E 5
Kingsdale	103	H 6
Kingston	21,096	K 3
Kintnersville	77	M 4
Kinzua	475	E 2
Kirkwood	102	K 6
Kistler	468	*G 5
Kittanning	7,731	C 4
Knobsville	117	G 6
Knox	1,213	C 3
Knoxville	656	H 2
Koppel	1,137	B 4
Kresgeville	250	L 4
Kulpmont	5,199	J 4
Kulpsville		M 5
Kunkletown	300	M 4
Kushequa	100	E 2
Kutztown	3,110	L 4
Kyler		E 3
La Anna	120	M 3
La Jose	180	E 4
La Plume	50	L 2
Laceyville	505	K 2
Lackawaxen	450	N 3
Laflin	256	*L 3
Lairdsville	150	J 3
Lake Ariel	400	M 3
Lake Como	102	M 2
Lakemont	1,600	F 5
Lakewood	200	M 2
Lamar	225	H 4
Lamartine	250	C 3
Lampeter	443	K 6
Lancaster	63,774	K 5
Landenberg	225	L 6
Lander	131	D 2
Landingville	230	*K 4
Landisburg	279	H 5
Lanesboro	591	M 2
Langdondale	300	F 5
Langeloth	1,068	A 5
Langhorne	1,579	N 5
Langhorne Manor	781	*N 5
Lansdale	9,762	M 5
Lansdowne	12,169	M 7
Lanse	300	F 4
Lansford	7,487	L 4
Laporte	199	K 3
Larabee	50	F 2
Large	500	C 7
Larimer	1,057	C 5
Larksville	6,360	*L 3
Latrobe	11,811	D 5
Laurel	159	K 6
Laurel Gardens	1,200	B 6
Laurel Run	858	*L 3
Laureldale	3,585	L 5
Laurelton	375	H 4
Lavery		B 2
Lawn	200	J 5
Lawrenceville	479	H 2
Lawton	140	K 2
Le Raysville	310	K 2
Le Roy	125	J 2
Lebanon	28,156	K 5
Lebanon Independent	2,778	*K 5
Lecontes Mills	200	F 3
Leechburg	4,042	C 4
Leeper	275	D 3
Leesburg	150	B 3
Leesport	700	K 5
Leetsdale	2,411	B 4
Lehighton	6,565	L 4
Lehman	580	K 3
Lemasters	325	G 6
Lemont	1,100	G 4
Lemont Furnace		C 6
Lemoyne	4,605	J 5
Lenhartsville	229	L 4
Lenni Mills	200	L 7
Lester	2,100	M 7
Levittown		N 5
Lewis Run	694	E 2
Lewisberry	299	J 5
Lewisburg	5,268	J 4
Lewistown	13,894	G 4
Lewisville	200	L 6
Lewisville (Ulysses)	495	G 2
Liberty	271	H 2
Liberty	1,900	C 7
Library	2,124	B 7
Ligonier	2,160	D 5
Lilly	1,898	E 5
Lima	580	L 7
Lincoln	930	K 5
Lincoln University		L 6
Linden	262	H 3
Linesville	1,246	A 2
Linfield	1,025	L 5
Linglestown	400	J 5
Linwood	5,000	L 7
Listie	700	D 5
Listonburg	145	D 6
Lititz	5,568	K 5
Little Marsh	100	H 2
Little Meadows	196	K 2
Littlestown	2,635	H 6
Livermore	57	*D 5
Liverpool	654	H 4
Livonia	32	H 4
Lock Haven	11,381	H 3
Loganton	346	H 3
Loganville	569	J 6
Long Branch	450	*C 5
Long Pond	50	L 3
Lookout	300	M 2
Lopez	800	K 3
Lorain	1,406	*E 5
Lords Valley		N 3
Loretto	863	E 4
Lottsville	150	D 2
Loyalhanna	500	D 5
Loyalton	200	J 4
Loysburg	175	F 5
Loysville	500	H 5
Lucernemines	1,075	D 4
Lucinda	350	D 3
Ludlow	500	E 2
Lumber City	262	*E 4
Lumberville	225	N 5
Luthersburg	240	E 3
Luzerne	6,176	L 3
Lykens	2,735	J 4
Lyndora	4,800	B 4
Lyon Station (Lyons)	545	L 5
Macdonaldton	400	E 6
Mackeyville	200	H 3
Macungie	983	L 4
Maddensville	34	G 5
Madera		F 4
Madison	386	*C 5
Madley	45	E 6
Mahaffey	646	E 4
Mahanoy City	10,934	K 4
Mainesburg	300	J 2
Malvern	1,764	L 5
Mammoth	500	D 5
Manchester	1,264	J 5
Manheim	4,246	K 5
Manns Choice	313	F 6
Manor	1,230	C 5
Manorville	662	C 4
Mansfield	2,657	J 2
Mapleton Depot (Mapleton)	742	F 5
Maplewood	130	M 3
Marcus Hook	3,843	L 7
Marianna	1,269	B 5
Marienville	1,000	D 3
Marietta	2,442	J 5
Marion	650	G 6
Marion Center	433	D 4
Marion Heights	1,551	*K 4
Marklesburg (Aitch)	219	F 5
Markleton	92	D 6
Markleysburg	291	C 6
Mars	1,385	C 4
Marsh Hill	100	H 3
Marshalls Creek	200	M 3
Martins Creek	1,000	M 4
Martinsburg	1,562	F 5
Marvindale	50	E 2
Marwood	125	C 4
Marysville	2,158	H 5
Masontown	4,550	C 6
Matamoras	1,761	N 3
Mattawana	253	G 5
Mauch Chunk (Jim Thorpe)	2,959	L 4
Mayburg	39	D 2
Mayfield	2,373	L 2
McAdoo	4,260	L 4
McAlisterville	515	H 4
McClure	1,000	H 4
McConnellsburg	1,126	F 6
McCrea	150	H 5
McDonald	3,543	B 5
McElhattan	175	H 3
McEwensville	297	*J 3
McGees Mills	112	E 4
McKean	379	B 2
McKees Rocks	16,241	B 7
McKeesport	51,502	C 7
McLane	212	B 2
McSherrystown	2,510	H 6
McVeytown	546	G 4
Meadow Lands	1,059	B 5
Meadville	18,972	B 2
Mechanicsburg	6,786	H 5
Mechanicsville	540	*K 4
Media	5,726	L 7
Medix Run	100	F 3
Mehoopany	250	K 2
Mercer	2,397	B 3
Mercersburg	1,613	G 6
Merion Station	2,000	M 6
Mertztown	200	L 4
Meshoppen	574	L 2
Mexico	275	H 4
Meyersdale	3,137	E 6
Middleboro (McKean)	379	B 2
Middleburg	1,283	H 4
Middlebury Center	90	H 2
Middleport	942	L 4
Middletown	9,184	J 5
Midland	6,491	A 4
Midway	993	B 5
Mifflin	835	H 4
Mifflinburg	2,259	H 4
Mifflintown	1,013	H 4
Milanville	200	M 2
Mildred	1,000	K 3
Milesburg	733	G 4
Milford	1,111	N 3
Mill Creek	417	G 5
Mill Hall	1,677	G 3
Mill Run	300	C 6
Mill Village	324	C 2
Millbourne	901	*M 6
Millersburg	2,861	J 4
Millerstown	682	H 4
Millerstown (Chicora)	1,172	C 4
Millersville	2,551	K 6
Millerton	250	J 2
Millheim	750	G 4
Millmont	250	H 4
Millport	250	F 2
Millrift	206	N 3
Mills	150	G 2
Millsboro	1,100	B 6
Millvale	7,287	B 7
Millville	878	J 3
Millway	200	K 5
Milmont Park	2,200	M 7
Milroy	1,443	G 4
Milton	8,578	J 3
Mineral Point	350	E 5
Minersville	7,783	K 4
Mines	160	F 5
Modena	824	*L 6
Mohnton	2,004	L 5
Mohrsville	600	K 5
Mollenauer	700	B 7
Monaca	7,415	B 4
Monessen	17,896	C 5
Monongahela	8,922	B 5
Monroeton (Monroe)	466	J 2
Mont Alto	984	G 6
Montgomery	2,166	H 3
Montoursville	3,293	J 3
Montrose	2,075	L 2
Moon Run	1,143	B 5
Moosic	3,965	L 3
Morgantown	415	L 5
Morris	257	H 2
Morris Run	600	J 2
Morrisdale	1,000	F 4
Morrisville	6,787	N 5
Morton	1,352	M 7
Moscow	1,050	L 3
Mosgrove		D 4
Moshannon	500	F 3
Mount Alton	105	E 2
Mount Carbon	302	*K 4
Mount Carmel	14,222	K 4
Mount Gretna	83	*J 5
Mount Holly Springs	1,701	H 5
Mount Jewett	1,415	E 2
Mount Joy	3,006	K 5
Mount Lebanon	†26,604	B 7
Mount Morris		B 6
Mount Oliver	6,646	*B 7
Mount Penn	3,635	*L 5
Mount Pleasant	5,883	D 5
Mount Pocono	619	M 3
Mount Union	4,690	G 5
Mount Wolf	1,164	J 5
Mountainhome	750	M 3
Mountville	1,064	K 5
Moylan	300	L 7
Muir	950	J 4
Muncy	2,756	J 3
Muncy Valley	310	J 3
Munhall	16,437	C 7
Munson	460	F 4
Murrysville	800	C 5
Myerstown	3,050	K 5
Nanticoke	20,160	K 3
Nanty Glo	5,425	E 5
Narberth	5,407	M 6
Natrona		C 4
Nazareth	5,830	M 4
Needmore	104	F 6
Neelyton	100	G 5
Neffs Mills	55	G 4
Nelson		H 2
Nemacolin	1,930	B 6
Nescopeck	1,907	K 3
Nesquehoning		L 4
New Albany	365	J 2
New Alexandria	523	C 5
New Baltimore	221	E 6
New Bedford	550	A 3
New Berlin	589	J 4
New Bethlehem	1,604	D 3
New Bloomfield	1,098	H 5
New Brighton	9,535	B 4
New Britain	581	*M 5
New Buena Vista	300	E 5
New Buffalo	155	H 5
New Castle	48,834	B 3
New Centerville	145	D 6
New Columbia	500	H 3
New Columbus	152	*L 3
New Cumberland	6,204	J 5
New Eagle	2,316	B 5
New Enterprise	317	F 5
New Florence	924	D 5
New Freedom	1,271	J 6
New Freeport	150	B 6
New Galilee	507	A 4
New Germantown	140	G 5
New Holland	2,602	K 5
New Hope	1,066	N 5
New Kensington	25,146	C 4
New Lebanon	179	B 3
New Milford	880	L 2
New Millport	200	F 4
New Oxford	1,366	H 6
New Paris	202	E 5
New Philadelphia	2,200	K 4
New Providence	220	K 6
New Ringgold	302	*K 4
New Salem	1,000	C 6
New Salem (Delmont)	695	D 5
New Salem (York New Salem)	333	*J 6
New Tripoli	258	L 4
New Washington	65	*E 4
New Wilmington	1,943	B 3
Newburg	182	G 5
Newburg	289	*E 4
Newfield	100	G 2
Newfoundland	650	M 3
Newport	1,893	H 5
Newry	412	F 5
Newton Hamilton	397	G 5
Newtown	2,095	N 5
Newville	1,788	H 5
Nicholson	979	L 2
Nickleville	100	C 3
Nineveh	76	B 6
Nisbet	396	H 3
Normalville	250	D 5
Norristown	38,126	M 5
North Apollo	1,502	D 4
N. Bellevernon	3,147	*C 5
North Bend	100	G 3
North Braddock	14,724	*C 7
N. Catasauqua	2,629	*M 4
North Charleroi	2,554	*C 5
North East	4,247	C 1
North Girard	1,369	B 1
North Irwin	1,076	*C 5
North Mehoopany	120	K 2
North Springfield		A 1
North Wales	2,998	M 5
North Warren	900	D 2
North York	2,445	*J 5
Northampton	9,332	M 4
Northumberland	4,207	J 4
Norvelt		D 5
Norwood	5,246	M 7
Noxen	400	K 3
Nu Mine	2,000	D 4
Nuangola	295	*C 4
Nuremberg	1,200	K 4
Oak Hall Station	225	G 4
Oak Ridge	800	D 3
Oakdale	1,572	B 5
Oakford	1,900	N 5
Oakland	871	L 2
Oakmont	7,264	C 6
Oakville	116	H 5
Ohiopyle	345	D 6
Oil City	19,581	C 3
Oklahoma	930	*C 4
Olanta	125	E 4
Old Forge	9,749	L 3
Oley	498	L 5
Oliver	2,180	C 6
Olyphant	7,047	L 3
Oneida	800	K 4
Ono	220	J 5
Orangeville	424	K 3
Orbisonia	648	G 5
Ore Hill	150	F 5

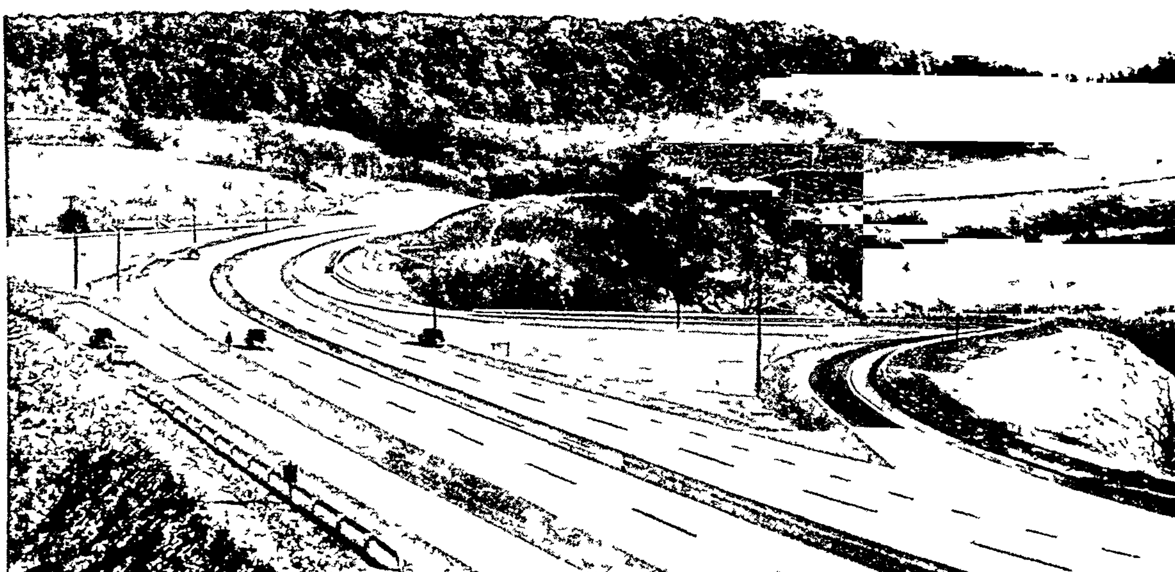
*No room on map for name.
†Population of town (township).

Ormsby	169	E 2
Orrstown	295	G 5
Orrtanna	300	H 6
Orson	250	M 2
Orviston	340	G 3
Orwigsburg	3,029	K 4
Osborne	496	*B 5
Osceola	300	H 2
Osceola Mills	1,992	F 4
Osterburg	200	E 5
Oswayo	167	G 2
Ottsville	817	M 5
Overton		K 2
Oxford	3,091	K 6
Paint	1,547	E 5
Palmerton	6,646	L 4
Palmyra	5,910	J 5
Palo Alto	1,767	*K 4
Paoli	2,039	M 5
Paradise	600	K 5
Pardoe	200	B 3
Parker	979	C 3
Parkesburg	2,611	L 6
Parkside	1,637	M 7
Parryville	598	*L 4
Patterson Heights	678	*B 4
Patton	3,148	E 4
Paupack	250	M 3
Pavia	100	E 5
Paxtang	1,857	*J 5
Peach Bottom	80	K 6
Pen Argyl	3,878	M 4
Penbrook	3,691	*J 5
Penfield	831	E 3
Penn	987	C 5
Penndel	1,100	*N 5
Penn Run	232	D 4
Pennline	25	A 2
Penns Park	160	N 5
Pennsburg	1,625	M 5
Pennsdale	200	J 3
Pennsylvania Furnace	100	G 4
Pequea	121	K 6
Perkasie	4,358	M 5
Perrysville	1,500	B 6
Petersburg	621	G 4
Petrolia	571	C 3
Philadelphia	2,071,605	N 6
Philipsburg	3,988	F 4
Phoenixville	12,932	L 5
Picture Rocks	569	J 3
Pillow	369	J 4
Pine Bank	25	B 6
Pine Grove	2,237	K 4
Pine Grove Furnace	40	H 5
Pine Grove Mills	1,200	G 4
Pipersville	125	M 5
Pitcairn	5,857	C 5
Pittock	2,600	B 7
Pittsburgh	676,806	B 7
Pittsfield		D 2
Pittston	15,012	L 3
Plains	†12,541	L 3
Platea	290	B 2
Pleasant Gap	1,312	G 4
Pleasant Hills	3,808	B 7
Pleasant Mount	438	M 2
Pleasantville	704	C 2
Pleasantville	242	*E 5
Plumsteadville	312	M 5
Plumville	452	D 4
Plymouth	13,021	K 3
Pocono Lake	225	L 3
Pocono Pines	475	M 3
Point Marion	2,197	C 6
Point Pleasant	400	N 5
Poland Mines		B 6
Polk	4,004	C 3
Pond Eddy		N 3
Port Allegany	2,519	F 2
Port Carbon	3,024	K 4
Port Clinton	451	K 4
Port Matilda	685	F 4
Port Royal	800	H 4
Port Trevorton	280	J 4
Port Vue	4,756	C 7
Portage	4,371	E 5
Portersville	294	B 4
Portland	551	M 4
Pottersdale	325	F 3
Potterville	63	K 2
Pottstown	22,589	L 5
Pottsville	23,640	K 4
Powell	300	J 2
Powelton	315	F 4
President	100	C 3
Primos	500	M 7
Pringle	1,727	*L 3
Proctor	100	J 3
Prompton	197	M 2
Prospect	726	B 4
Prospect Park	5,834	M 7
Pulaski	350	B 3
Punxsutawney	8,969	E 4
Quakertown	5,673	M 5
Quarryville	1,187	K 6
Quecreek	550	D 5
Queen	200	E 5
Racine	500	B 4
Railroad	300	J 6
Rainsburg	189	F 6
Ralphton	225	D 5
Ralston	700	H 2
Ramey	696	F 4
Rankin	6,941	C 7
Ravine	600	K 4
Reading	109,320	L 5
Reamstown	950	K 5
Rebersburg	600	H 4
Red Hill	914	*M 5
Red Lion	5,119	J 6
Reedsville	1,238	G 4
Refton	235	K 6
Rehrersburg	365	K 5
Renfrew	400	C 4
Reno	1,000	C 3
Renovo	3,751	G 3
Rew	500	F 2
Reynoldsville	3,569	D 3
Rices Landing	796	C 6
Riceville	200	C 2
Richfield	350	H 4
Richland	1,090	K 5
Richlandtown	762	M 5
Riddlesburg	700	F 5
Ridgway	6,244	E 3
Ridley Park	4,921	M 7
Riegelsville	871	M 4
Rillton	875	C 5
Rimer	80	C 4
Rimersburg	1,398	D 3
Ringtown	835	K 4
Riverside	524	J 4
Rixford	650	F 2
Roaring Branch	375	J 2
Roaring Creek	40	K 4
Roaring Spring	2,771	F 5
Robertsdale		F 5
Robesonia	1,590	K 5
Robinson		D 5
Rochester	7,197	B 4
Rochester Mills	230	D 4
Rock Glen	250	K 4
Rockhill	567	*G 5
Rockledge	2,261	*M 5
Rockwood	1,237	D 6
Rogersville	300	B 6
Rome	257	K 2
Roscoe	1,396	C 5
Rose Valley	498	L 7
Rosemont	2,000	M 5
Roseto	1,676	M 4
Roseville (Rutland)	126	J 2
Rossiter	1,078	E 4
Rosslyn Farms	448	*B 7
Rothsville	1,000	K 5
Roulette	800	F 2
Rouseville	1,009	C 3
Rouzerville	1,000	G 6
Roxbury	400	G 5
Royalton	1,175	J 5
Royersford	3,862	L 5
Rummerfield	100	K 2
Rural Valley	857	D 4
Rush		K 2
Russell	800	D 2
Russellton	1,670	C 4
Rutland	126	J 2
Rutledge	919	M 7
Sabinsville	300	G 2
Sabula	275	E 3
Saegerstown	836	B 2
Sagamore	1,128	D 4
Saint Benedict	500	E 4
Saint Clair	5,856	K 4
Saint Clairsville	127	*E 5
Saint Lawrence	810	*E 4
Saint Marys	7,846	E 3
Saint Petersburg	451	C 3
Saint Thomas	534	G 6
Salisbury	865	D 6
Salladasburg	250	H 3
Salona	500	H 3
Saltillo	435	G 5
Saltsburg	1,156	D 4
Sand Patch	56	E 6
Sandy Lake	767	B 3
Sandy Ridge	700	F 4
Sankertown	865	*E 5
Sarver	410	C 4
Sawyer City	500	E 2
Saxonburg	602	C 4
Saxton	1,093	F 5
Saybrook	137	D 2
Saylorsburg	513	M 4
Sayre	7,735	K 2
Scalp Level	1,756	E 5
Schaefferstown	1,000	K 5
Schellsburg	305	E 5
Schnecksville	375	L 4
Schuylkill Haven	6,597	K 4
Schwenksville	563	L 5
Sciota	300	M 4
Scotland	500	G 6
Scottdale	6,249	C 5
Scranton	125,536	L 3
Secane	1,500	M 7
Seelyville	600	M 2
Selinsgrove	3,514	J 4
Sellersville	2,373	M 5
Seminole	250	D 4
Seneca	700	C 3
Sergeant	150	E 2
Seven Valleys	437	J 6
Seward	852	E 5
Sewickley	5,836	B 4
Sewickley Heights	679	*B 4
Shade Gap	157	G 5
Shadygrove	500	G 6
Shamokin	16,879	J 4
Shamokin Dam	730	J 4
Shanksville	342	E 5
Sharon	26,454	B 3
Sharon Hill	5,464	N 7
Sharpsburg	7,296	B 6
Sharpsville	5,414	A 3
Shawanese	200	K 3
Shawmut		E 3
Shawnee on Delaware	200	N 3
Sheakleyville	141	B 3
Sheffield	2,087	D 2
Shelocta	105	*D 4
Shenandoah	15,704	K 4
Shenango	200	A 3
Sheppton		K 4
Shermans Dale	83	H 5
Shickshinny	2,156	K 3
Shillington	5,059	K 5
Shinglehouse	1,201	F 2
Shippensburg	5,722	H 5
Shippenville	522	D 3
Shippingport	408	*B 4
Shiremanstown	887	*H 5
Shirleysburg	241	G 5
Shoemakersville	1,066	K 4
Shohola	600	N 3
Shohola Falls	70	N 3
Shrewsbury	787	J 6
Shunk	60	J 2
Sidman	490	E 5
Sigel	600	D 3
Silverdale	384	*M 5
Simpson	2,800	M 2
Sinking Spring	1,982	K 5
Sinnamahoning	450	G 3
Six Mile Run	400	F 5
Skinners Eddy	225	K 2
Skippack	425	M 5
Skytop	25	M 3
Slate Run		H 3
Slatedale	800	L 4
Slatington	4,343	L 4
Slickville	1,266	C 5
Sligo	913	C 3
Slippery Rock	2,294	B 3
Smethport	1,797	F 2
Smicksburg	92	D 4
Smithfield	1,066	C 6
Smithmill	1,500	F 4
Smithton	690	C 5
Snow Shoe	670	G 3
Snydertown	314	J 4
Soldier	300	E 3
Somerset	5,936	D 6
Sonestown	275	K 3
Souderton	4,521	M 5
South Bend	100	D 4
South Bethlehem	489	*D 4
South Coatesville	1,996	*L 6
South Connellsville	2,616	D 6
South Fork	2,616	E 5
South Greensburg	2,980	*C 5
South Heights	691	B 4
South Mountain	1,300	H 6
South New Castle	993	*B 4
South Philipsburg	512	*F 4
South Renovo	862	G 3
South Waverly	1,298	J 2
South Williamsport	6,364	J 3
Southmont	2,278	*E 5
Southwest	800	C 5
Southwest Greensburg	3,144	*C 5
Spangler	3,013	E 4
Spartansburg	482	C 2
Speers	1,089	*C 5
Spinnerstown	400	M 5
Spring City	3,258	L 5
Spring Creek	160	D 2
Spring Grove	1,238	J 6
Spring Mills	720	G 4
Springboro	611	B 2
Springdale	4,939	C 4
Springfield	8,000	M 7
Springtown	600	M 4
Springville	250	L 2
Spruce Creek	150	F 4
Starrucca	326	M 2
State College	17,227	G 4
State Line	375	G 6
Steelton	12,574	J 5
Sterling	40	M 3
Sterling Run	225	F 3
Stewartstown	1,133	K 6
Stillwater	189	K 3
Stockdale	870	*C 5
Stockertown	757	M 4
Stoneboro	1,294	B 3
Stowe	2,524	L 5
Stowe	†12,210	B 7
Stoystown	517	E 5
Strasburg	1,109	K 6
Strattanville	562	D 3
Strausstown	368	K 5
Stroudsburg	6,361	M 4
Stump Creek	675	E 3
Sturgeon	1,150	B 5
Sugar Notch	2,002	L 3
Sugargrove	520	D 1
Summerhill	849	E 5
Summerville	933	D 3
Summit Hill	4,294	L 4
Sunbury	15,570	J 4
Surveyor	53	F 3
Susquehanna	2,646	L 2
Sutersville	854	*C 5
Swarthmore	4,825	M 7
Sweet Valley	200	K 3
Swissvale	16,488	C 7
Swoyersville	7,795	*L 3
Sycamore	69	B 6
Sykesville	1,652	E 3
Sylvan	22	G 6
Sylvania	211	J 2
Tamaqua	11,508	L 4
Tamarack	60	G 3
Tannersville	500	M 3
Tarentum	9,540	C 4
Tatamy	681	M 4
Taylor	7,176	L 3
Taylorstown	326	A 5
Telford	2,042	*M 5
Temple	1,460	L 5
Templeton	1,000	C 4
Terre Hill	1,000	L 5
Thomasville	320	J 6
Thompson	320	L 2
Thompsontown	486	H 4
Thornburg	335	*B 7
Thornhurst	100	L 3
Three Springs	417	G 5
Throop	5,861	L 3
Tidioute	998	D 2
Timblin	327	D 4
Tioga	544	H 2
Tiona	350	D 2
Tionesta	728	C 2
Tipton	425	F 4
Tire Hill	700	E 5
Titusville	8,923	C 2
Tobyhanna	825	M 3
Topton	1,572	L 5
Torpedo	65	D 2
Torrance	500	D 5
Toughkenamon	500	L 6
Towanda	4,069	J 2
Tower City	2,054	J 4
Townville	351	C 2
Trafford	3,965	C 5
Trainer	2,001	L 7
Transfer	400	A 3
Trappe	773	*M 5
Tremont	2,102	K 4
Trevorton	2,545	J 4
Trexlertown	500	L 4
Trough Creek	60	F 5
Trout Run	325	H 3
Troutville	223	*E 3
Troxelville	130	H 4
Troy	1,371	J 2
Truemans	80	D 2
Trumbauersville	838	M 5
Tryonville	134	C 2
Tullytown	648	N 5
Tunkhannock	2,170	L 2
Tunnelhill	535	*E 5
Turbotville	518	J 3
Turtle Creek	12,363	C 7
Turtlepoint	150	F 2
Twilight	318	*C 5
Twin Rocks	1,850	E 4
Tyler	250	F 3
Tylersburg	215	D 3
Tylersville	200	G 4
Tyrone	8,214	F 4
Ulster	400	J 2
Ulysses	495	G 2
Union City	3,911	C 2
Union Dale	350	M 2
Union Deposit	550	J 5
Uniontown	20,471	C 6
Uniontown	1,280	*J 4
Unionville	341	*H 4
Unity	700	C 4
Unityville	55	K 3
Universal	3,200	C 7
Upland	4,081	L 7
Upper Black Eddy	550	N 4
Upper Darby	†84,951	M 6
Upper Strasburg	262	G 5
Urban	100	J 4
Ursina	334	D 6
Utica	264	C 3
Uwchland	300	L 5
Valencia	298	C 4
Valier	600	D 4
Valley Forge	475	L 5
Valley View	1,618	J 4
Van	75	C 3
Vanderbilt	937	C 5
Vandergrift	9,524	D 4
Vandling	722	M 2
Vanport	2,500	B 4
Venango	359	B 2
Venus	150	C 3
Verona	4,235	C 6
Versailles	2,484	C 7
Villanova	1,500	M 6
Vintage	150	K 5
Vintondale	1,185	E 5
Volant	229	B 3
Wall	1,850	C 5
Wallaceton	440	F 4
Wallingford	6,000	L 7
Walnut	85	G 4
Walnut Bottom	325	H 5
Walnutport	1,427	L 4
Walston	330	D 4
Wampum	1,090	B 4
Wanamie	1,092	L 3
Wapwallopen	377	K 3
Warfordsburg	105	F 6
Warren	14,849	D 2
Warren Center	275	K 2
Warrendale	600	B 4
Warrensville	175	J 3
Warrior Run	1,056	*L 3
Warriors Mark	225	F 4
Washington	26,280	B 5
Washington Boro	483	*K 6
Washington Crossing	300	N 5
Washingtonville	194	J 3
Waterford	1,195	B 2
Watsontown	2,327	J 3
Wattsburg	343	C 1
Wawa	600	L 7
Waymart	1,068	M 2
Wayne	6,000	M 6
Waynesboro	10,334	G 6
Waynesburg	5,514	B 6
Weatherly	2,622	L 4
Webster		C 5
Webster Mills	95	F 6
Weedville	700	F 3
Weissport	674	*L 4
Wellersburg	369	E 6
Wellsboro	4,215	H 2
Wellscreek	100	E 5
Wellsville	309	J 5
Wernersville	1,280	K 5
Wesley	80	C 3
Wesleyville	3,411	C 1
West Alexander	466	B 5
West Bridgewater	1,316	B 4
West Brownsville	1,610	C 5
West Chester	15,168	L 6
West Conshohocken	2,482	*M 5
West Easton	1,368	*M 4
West Elizabeth	1,137	C 5
West Fairview	1,896	*J 5
West Finley	93	B 5
West Grove	1,521	L 6
West Hazleton	6,988	K 4
West Hickory	400	C 2
West Homestead	3,257	*B 7
West Kittanning	910	*C 4
West Lawn	2,144	K 5
West Leechburg	1,113	*C 4
West Leesport	535	*L 5
West Liberty	245	*C 5
West Mayfield	1,768	*B 4
West Middlesex	1,217	B 3
West Middletown	268	A 5
West Mifflin	17,985	C 7
West Milton	700	J 3
West Monterey	125	C 3
West Nanticoke	1,780	K 3
West Newton	3,619	C 5
West Pittsburg	900	B 4
West Pittston	7,230	*L 3
West Reading	5 072	*L 5
West Salisbury	300	D 6
West Springfield		B 2
West Sunbury	262	B 4
West Union	25	B 6
West View	7,581	B 6
West Winfield	600	C 4
West Wyoming	2,863	*L 3
West York	5,756	*J 6
Westfield	1,357	H 2
Westford	47	A 2
Westland	1,025	B 5
Westline	150	E 2
Westmont	4,410	*C 5
Weston	602	K 4
Westover	605	E 4
Westport	221	G 3
Westtown	258	L 6
Westville	250	E 3
Wharton	50	G 2
Wheatland	1,402	B 3
Wheelerville	34	J 2
Whitaker	2,149	C 7
White Haven	1,461	L 3
White Mills	600	M 2
White Oak	6,159	C 7
Whitedeer	300	J 3
Whitehall	7,342	B 7
Whitney	875	D 5
Wiconisco	1,549	J 4
Widnoon	350	D 4
Wilawana	100	J 2
Wilcox	1,000	E 2
Wilkes-Barre	76,826	L 3
Wilkinsburg	31,418	C 7
Williamsburg	1,792	F 5
Williamsport	45,047	H 3
Williamstown	2,332	J 4
Willock	275	B 7
Willow Grove	7,000	M 5
Willow Hill	440	G 5
Wilmerding	5,325	C 7
Wilmore	390	E 5
Wilpen		D 5
Wilson	8,159	M 4
Winburne	785	F 4
Windber	8,010	E 5
Windgap	1,577	M 4
Windsor	1,126	J 6
Winfield	320	J 4
Wingate	216	G 4
Winterdale	50	M 2
Winterstown	298	*J 6
Winton	6,280	M 3
Wolfdale	800	B 5
Wolfsburg	125	F 5
Womelsdorf	1,549	K 5
Woodbury	254	F 5
Woodcock	130	C 2
Woodland	1,000	F 4
Woodlyn	5,000	M 7
Woodruff	25	B 6
Woodville	3,775	B 7
Woolrich	450	H 3
Wormleysburg	1,511	*J 5
Worthington	800	C 4
Worthville	73	D 3
Wrights	250	F 2
Wrightsville	2,104	J 5
Wyalusing	612	K 2
Wyoming	4,511	L 3
Wyomissing	4,187	K 5
Wyomissing Hills	646	*K 5
Wysox	250	K 2
Yardley	1,916	N 5
Yatesboro	1,264	D 4
Yatesville	565	*L 3
Yeadon	11,068	N 7
Yeagertown	1,628	G 4
Yoe	681	*J 6
York	59,953	J 6
York Haven	743	J 5
York Springs	413	H 6
Yorkana	229	*J 6
Youngstown	577	D 5
Youngsville	1,944	D 2
Youngwood	2,720	D 5
Yukon	1,099	C 5
Zelienople	2,981	B 4

*No room on map for name.
†Population of town (township).

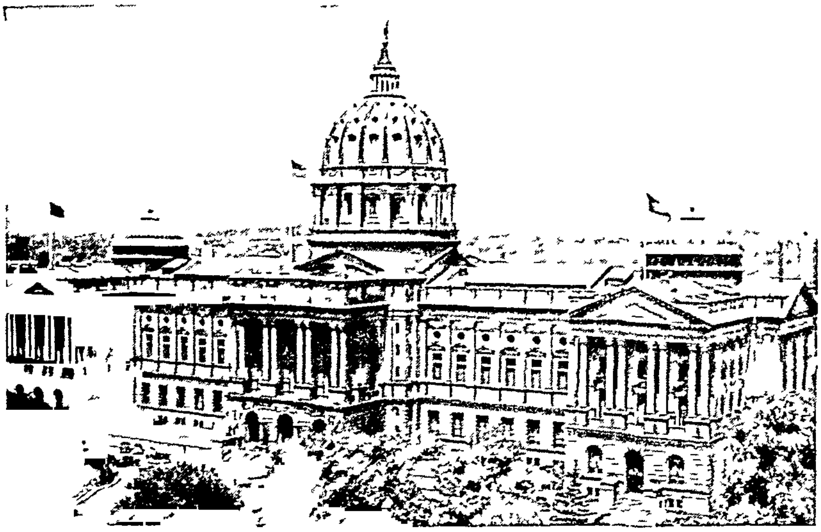
ONE OF AMERICA'S FINEST SUPERHIGHWAYS

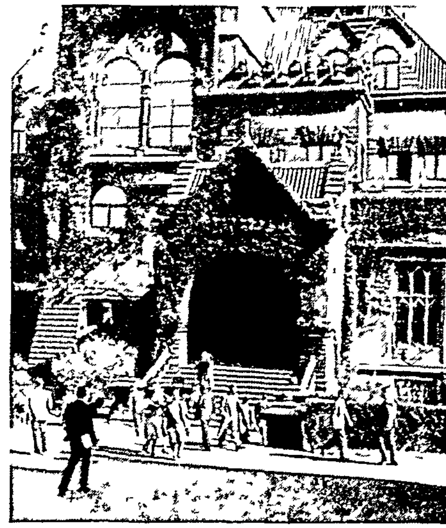




On the Pennsylvania Turnpike automobiles and trucks safely and rapidly cross the state, east or west. Top, an automobile emerges from one of the toll road's seven tunnels that pierce the Alleghenies. Vehicles enter or leave the expressway at the Bedford Interchange (bottom), one of the interchanges where the road crosses main highways.

DIGNIFIED HALLS OF GOVERNMENT AND LEARNING





On Capitol Hill in Harrisburg is Pennsylvania's magnificent State Capitol. Atop the dome a figure symbolizes the Commonwealth. The ivy-covered walls of the library of the University of Pennsylvania at Philadelphia suggest its scholarly tradition.

The lofty bell tower of imposing Old Main rises above the campus of Pennsylvania State University at State College.

One of the state's nationally famous private schools is Temple University in Philadelphia. Here is its School of Medicine.

Erie, on Lake Erie, is Pennsylvania's great lake port. Its splendid harbor is guarded by Presque Isle, a peninsula that stretches for seven miles along the city's lake shore. One of Pennsylvania's more than 30 state parks is located here. Erie is also an important railway center and manufacturing city. A great variety of products are made here, but the largest industries are those that produce machinery, paper, steel, and rubber goods (*see* Erie).

In the south-central part of the state are Altoona, Pennsylvania's great railroad city, and Johnstown, located in the heart of vast bituminous coal beds. Scranton, on the Lackawanna River, and Wilkes-Barre, on the Susquehanna River, both in the anthracite region, are mining and manufacturing cities (*see* Scranton; Wilkes-Barre). In southeastern Pennsylvania are Harrisburg (the state capital), Lancaster, York, and Reading (*see* Harrisburg; Reading). Lancastei and York lie in the rich agricultural country in the Susquehanna Valley. The metropolis of the Lehigh Valley is Allentown. It makes textiles, clothing, machinery, metal products, and hydraulic cement (*see* Allentown). Near Allentown is Bethlehem, famous for steel. Both are on the Lehigh River. Its valley has limestone deposits used in cementmaking.

Other important cities are McKeesport, in southwestern Pennsylvania; Chester, to the southwest of Philadelphia; and New Castle, north of Pittsburgh.

Pennsylvania's first constitution was adopted in 1776. The present constitution, adopted in 1874, provides for a senate and a house of representatives in a general assembly. The governor, lieutenant governor, auditor general, state treasurer, and secretary of internal affairs are elected for four years.

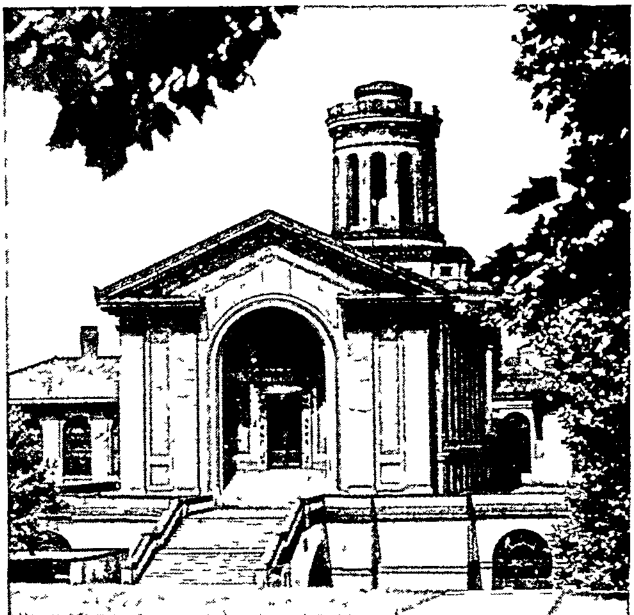
High Educational Standards

From the days of the earliest settlers, Pennsylvania has always been active in promoting education. William Penn's charter of 1681 provided for a committee on education, and the second Colonial Assembly in 1683 provided for compulsory elementary

education. In 1689 the Friends' Public Grammar School for higher education was opened in Philadelphia, and it still continues as the William Penn Charter School. Other religious groups among the first settlers—Presbyterians, Mennonites, Moravians, and Lutherans—established their own schools, some of which are still maintained.

Today there are about 70 universities and colleges in the state. The University of Pennsylvania, at Philadelphia, traces back to 1740; and its name dates from 1791. Pennsylvania State University is at State College. Among the others are the University of Pittsburgh, Temple University, Carnegie Institute of Technology, Swarthmore College, Dickinson College, Washington and Jefferson College, Bryn Mawr College, Lafayette College, Franklin and Marshall College, Bucknell University, and Lehigh University. There are also a number of state teachers colleges and normal schools.

PITTSBURGH'S GREAT SCIENTIFIC SCHOOL



Machinery Hall, shown here, is part of the Carnegie Institute of Technology. The Institute was founded and endowed in 1905 by Andrew Carnegie, and it ranks with the foremost technical schools in the United States. Its splendidly equipped buildings occupy a rolling campus of approximately 70 acres.

Colonial History

Henry Hudson established the claim of the Dutch to Pennsylvania and adjacent territory. In 1609 he cast anchor in Delaware Bay after scanning every inlet along the Atlantic coast for a waterway through the American continent to China (*see* Hudson, Henry). In 1643 the stalwart Johan Printz, recently arrived governor of New Sweden, moved from Fort Christina at Wilmington to Tinicum Island, just below the present site of Philadelphia. Here he founded New Gottenburg, the first permanent settlement in Pennsylvania.

The thrifty and industrious Swedish settlers cultivated the soil, trapped for furs, and, with their cattle and grain raising, grew prosperous along the Delaware's marshes and meadows. Swedish rule lasted only 17 years. The Dutch of New Netherland grew jealous of the intrusion, and under the leadership of Gov. Peter Stuyvesant, they seized the Swedish colony in 1655. Nine years later the Dutch in turn were ousted by the English, who annexed the territory to New York.

Tales of this beautiful Indian country incited the rich and zealous Quaker leader William Penn to seek in America a refuge not only for his persecuted followers, but for people of all creeds. Charles II granted him a huge domain of some 50,000 square miles between New York and Maryland in payment for a debt of £16,000, which the king had owed Penn's father, who was dead (*see* Penn). In 1681 the first band of Quakers arrived, led by Penn's cousin, William Markham. In honor of Penn's father the land was named Pennsylvania. Penn himself came the next year with more Quakers and made a treaty with the Delaware Indians at Shackamaxon (now Kensington district in Philadelphia). Under the treaty, Quakers and Indians lived in peace for almost 70 years.

The religious freedom and liberal rule of Pennsylvania attracted people of many beliefs and nationalities. Dutch and Swedish were already there when the Quakers arrived. Welsh Quakers settled west of the Schuylkill River at Bryn Mawr, Haverford, and Pennllyn, on land that became known as the Welsh Tract.

Great numbers of German and Dutch Mennonites came in 1683, led by Francis Daniel Pastorius, to settle at Germantown, near Philadelphia. Pastorius later signed, and possibly originated, the first petition in America for the abolition of slavery. These Germans were skilled weavers, printers, lace makers, and silversmiths By 1690 they had erected the first paper mill in America on Wissahickon Creek. Other German religious groups followed the Mennonites, among them the Dunkers, Schwenkfelders, and Moravians Nazareth and Bethlehem were founded by the Moravians; the Dunkers built a monastery at Ephrata. Other immigrants pushed through the wilderness to Berks, Montgomery, and Lehigh counties, and their descendants still are known as "Pennsylvania Dutch."

Scotch-Irish, stanch Presbyterians, and able farmers, came early in the 18th century to invade the Cumberland Valley and push on to the wild northern and western frontiers. Hardy and energetic, they were well suited to cope with the savage Indians and the hardships of frontier life. Huguenots from France, Episcopalians, Lutherans, and other religious groups mingled also in Penn's refuge. Soon many flourishing cities were scattered over Pennsylvania, and Philadelphia became the largest city in America.

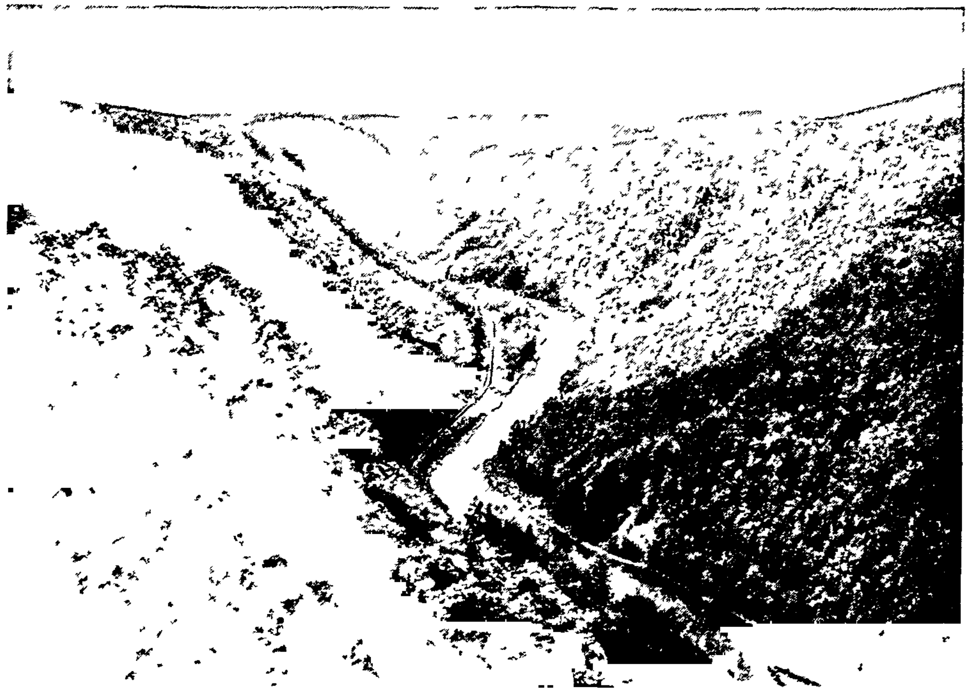
Pennsylvania's Boundary Dispute

Pennsylvania early became entangled in disputes over its boundaries with Delaware, Maryland, Connecticut, New York and Virginia. The dispute with Maryland and Delaware was settled in 1763, when

Charles Mason and Jeremiah Dixon, two English surveyors, were assigned to draw the southern boundary of Pennsylvania (*see* Mason and Dixon's Line). An extension of Mason and Dixon's line later settled Virginia's claim.

Connecticut claimed the land along the Susquehanna River in northeastern Pennsylvania, known as the Wyoming Valley, and a colony of Connecticut Yankees settled there. The "Erie Triangle," claimed by both New York and Massachusetts as their part of the Northwest Territory, was ceded by them to the Federal government, and then was purchased from the United States by Pennsylvania in 1792. Thus the state got its outlet on Lake Erie.

THE "GRAND CANYON" OF PENNSYLVANIA



Here we look down the steep, wooded slopes of Pine Creek Gorge in Tioga County in northern Pennsylvania. In some places this beautiful, 50-mile long gorge is 800 feet deep. It is popularly known as the "Grand Canyon" of Pennsylvania and is a favorite resort area. Along the gorge are Colton Point and Leonard Harrison State Parks.

The long period of friendly relations between the Quakers and the Indians was ended by the struggle between the French and English for control of the rich Ohio Valley. George Washington's first important assignments as a soldier loom prominently in the history of Pennsylvania during the French and Indian War of 1754–63 (*see* French and Indian War; Washington, George). The Quakers, reluctant to join, were forced to fight when the Indians raided settlements within 30 miles of Philadelphia.

Again in 1763 the Ottawa Indians, under Chief Pontiac, burned towns and farmhouses, and massacred colonists along the Pennsylvania frontier. They attacked Fort Pitt, which was saved only by the timely arrival of Col. Henry Bouquet and his troops.

Pennsylvania saw the most important events of the Revolution. The first Continental Congress met in Carpenters' Hall in Philadelphia. In Independence Hall, also in Philadelphia, the Declaration of Independence was signed, and the Liberty Bell rang out its tidings of freedom (*see* Declaration of Independence). Pennsylvania became an important battlefield of the war after Washington and his tattered forces retreated from Long Island across New Jersey and the Delaware River in 1776. In 1777, Brandywine and Germantown were the scenes of bloody battles before General Howe's British captured Philadelphia in September. That winter at Valley Forge Washington and his men saw the darkest days of the war.

In 1778 Pennsylvania was the scene of one of the worst atrocities of the Revolution, the "Wyoming Massacre." Wyoming was a frontier town near the present site of Wilkes-Barre. While most of the men were absent, serving in the American forces, a party of Tories and Indians fell upon the village, burned and pillaged as they advanced, murdered the few men they found, and drove the helpless women and children into the wilderness, where many perished.

In 1787, the Constitution of the United States was drafted at Philadelphia, and Pennsylvania was the second state to ratify it. Philadelphia was the capital of the United States from 1790 to 1800, and the state capital until 1799. That year the state capital was moved to Lancaster, and in 1812 to Harrisburg.

During the Civil War Pennsylvania saw many momentous struggles, among them the great battle of Gettysburg. Chambersburg was burned by Confederate forces in 1864. (*See also* Civil War, American; and chronology in Pennsylvania Fact Summary.)

Some Early Heroes of Pennsylvania

Greatest of Pennsylvania's colonial notables was Benjamin Franklin, who lived in Philadelphia (*see* Franklin). An earlier leader was James Logan (1674–1751), who was brought to Philadelphia by William Penn in 1699. Acting as Penn's secretary, he was practically governor of the colony for many years. He left a priceless library of some 3,000 volumes to Philadelphia, where it is still preserved in the Public Library. Christopher Sauer, or Sower (1693–1758), a leader in the Dunker colony at Germantown after 1719, published an almanac, a magazine, and books. In 1743 he printed a German edition of the Bible—the first Bible, except for Eliot's Indian version, that appeared in America. Sauer was an expert craftsman who made his own paper, ink, and type. John Bartram (1699–1777) whom Linnaeus described as "the greatest natural botanist in the world," made

a study of flora in America from southern Florida to Lake Ontario and at his home on the Schuylkill River established the country's first botanical garden, now maintained as a city park. Pennsylvania early produced two noted astronomers, Thomas Godfrey (1704–1749), and David Rittenhouse (1732–1796). Rittenhouse helped lay out the boundaries of Pennsylvania. Godfrey improved the quadrant.

A writer who helped rouse the colonists against unjust taxation by England was John Dickinson (1732–1808). His famous 'Farmer's Letters' did much to stir the feeling that brought on the Revolution. Dr. Benjamin Rush (1745–1813), who was born near Philadelphia, is often called "the father of American medicine." He was a signer of the Declaration of Independence. Pennsylvania produced one of the first noted American painters, Benjamin West (1738–1820). (*See* West.) Stephen Girard (1750–1831), who was born in France, landed in Philadelphia when he was 19 and became the richest American of his time. In 1793, when yellow fever killed perhaps 5,000 in Philadelphia, Girard enlisted businessmen to go with him to minister to the sick. At his death he left practically his whole fortune of nearly $8,000,000 to charities. The bulk of it went to establish Girard College for Orphans in Philadelphia. (*See also* United States, section "Middle Atlantic Region.")

PENSIONS. Regular payments called "pensions" were first granted as royal favors to men who served their king well or did outstanding work in art, literature, and science. In the 19th and 20th centuries, pensions were extended to many other classes. Nations, states, cities, and corporations came to pension workers who had become disabled or too old to continue work. In some cases, pensions were paid to dependents of persons who had died in discharge of their duties. War veterans, teachers, firemen, policemen, government employees, mothers, and aged persons now receive pensions under certain conditions.

The first pension in our own country was given in 1636 by Plymouth Colony to soldiers maimed in Indian fighting. In 1776 the Continental Congress pensioned disabled veterans of the Revolution in the first national pension law in the United States. In every war the federal government has granted to veterans increasingly liberal pensions, now totaling billions.

Disability pensions are given to those injured in service and to widows and dependents. Veterans may also receive *limited service pensions* for duty of a specified length and such requirements as age, indigence, and disability. After the war, they may receive *service pensions* solely for service. Service pensions were given veterans of the Revolutionary War in 1818; War of 1812, in 1871; Mexican War, in 1887; Indian wars, in 1892; and the Civil War, in 1920.

In World Wars I and II *compensation* was paid for disability based on earning capacity, similar to workmen's compensation. In 1924 veterans received a *bonus* to compensate for loss of earnings while in service. Whereas a pension is a regular, periodic payment to a disabled veteran or dependents, a bonus is a fixed lump payment to all veterans. In 1946 Congress distinguished between compensation and pensions, or between benefits for service-connected and nonservice-connected disability or death.

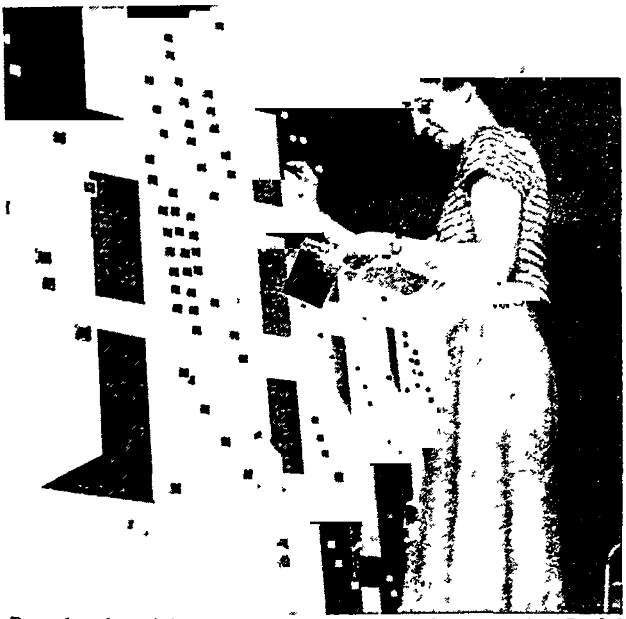
Veterans disabled in wartime service may get monthly compensation. The degree of disability and loss of earning power fix the amount, which ranges from $15.75 for minor disability to $172.50 for total disability. Additional sums are paid for such disabilities as blindness. Permanent and total disability not incurred in service may merit monthly pensions of $63 or $75 after ten years or after age 65. Widows and dependents of deceased veterans may be pensioned. Veterans of the Korean conflict receive similar benefits. (*See also* Veterans' Administration.)

The railroads were the first companies in the United States to set up disability and retirement plans for employees. Other industries followed. Dur-

HELPING TO SUPPORT THE AGED

Every year thousands of Americans reach 65 and become eligible for pensions under the provisions of the Social Security Act. The man at the left is seeking help in filling out his application for a pension. He will receive a regular monthly payment.

WHERE OLD-AGE RECORDS ARE KEPT



Records of social security payments are kept at the Social Security Board's accounting division in Baltimore, Md. Only authorized persons are admitted to these confidential files.

ing and after the second World War the growth of such plans was spectacular. At first labor unions were skeptical of company-sponsored plans. Many unions organized benefit plans for disabled or retired members. Today company pensions and retirement plans are subjects for collective bargaining. They may be financed jointly by employers and employees (contributory) or by the employer only (noncontributory).

National old-age pension systems have been established in several countries. In some nations, such as the United States, the system is based on a compulsory social insurance, to which employers, employees, and the government contribute. In other countries, the government pays the entire cost out of public funds. In Great Britain the social insurance system includes not only old-age pensions, but also insurance against unemployment, accidents, and sickness. In the United States, the Social Security Act, which was passed in 1935, provides that the Federal government coöperate with the pension laws of the various states (*see* Social Security).

Not all working groups receive benefits under the Social Security Act. Railroad workers are provided for by the Railroad Retirement Act, first passed in 1935. Public-school teachers may be pensioned by the individual states. Many states also pension non-teaching school employees. Some large cities maintain separate retirement systems for school employees.

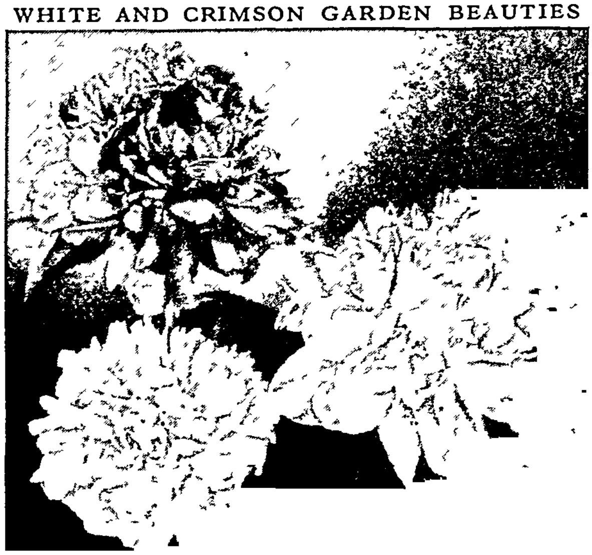
Since 1921 the United States has paid retirement benefits to aged or disabled civil service employees. Deductions from their salaries go into the pension fund. Many cities and states have similar systems. In 1946 Congress amended the Civil Service Retirement Act of 1930 to include members of Congress. To be eligible, congressmen must have held office for at least six years, must be 62 years old, and must have contributed to the pension fund. Some states have similar provisions for state legislators.

American territories and most states grant public aid to widowed and deserted mothers of dependent children. The first mothers' aid acts were passed in Missouri and in Illinois in 1911. Under the provisions of the Social Security Act most states receive federal funds for aid to dependent children.

PEONY. The peony, with its shining foliage and showy masses of brilliant bloom, is one of the commonest and most effective of our garden flowers. It has been cultivated at least since the days of the Roman author Pliny.

More than a thousand beautiful varieties of peonies exist. Nearly all of them are derived from the old-fashioned garden peony, which produces large, solitary blossoms, usually red or crimson but varying to white, early in the summer. Or they may stem from the white peony, a native of Siberia, which bears fragrant white and pink flowers. The flowers are usually double, but some varieties are single. The blooms of the Chinese peonies, a group of hardy hybrids, are fragrant and double. They vary in color from pure white to crimson and mahogany. All these peonies have soft stems and tuberous roots.

WHITE AND CRIMSON GARDEN BEAUTIES



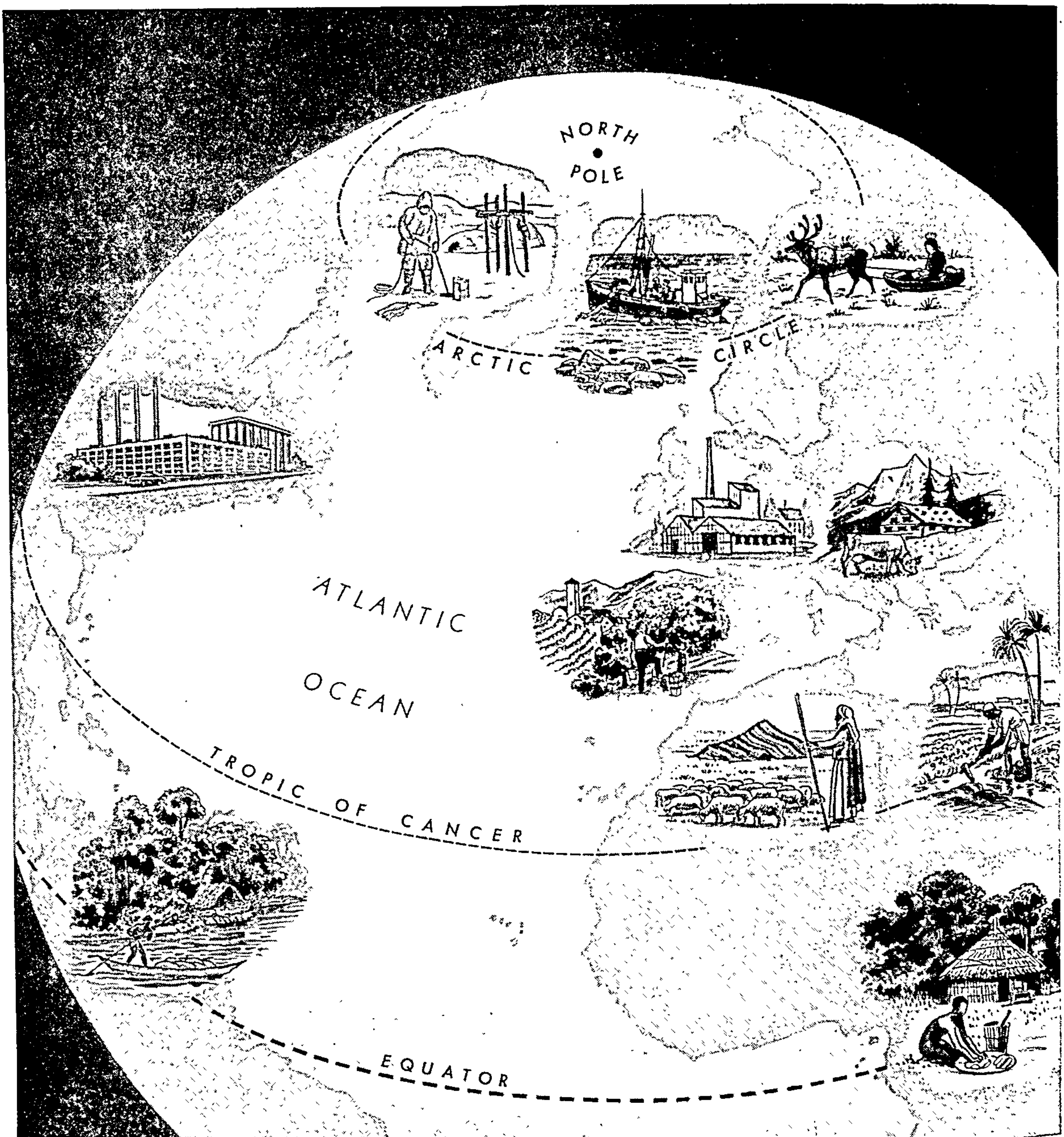
The showy peonies are favorite garden flowers. They were named for Paion, physician of the gods, because they were thought to have healing qualities.

Less common are the shrubby tree peonies with woody stems. One species, native to California and Japan, grows from five to six feet tall. It bears large, single or double, slightly fragrant flowers, often eight to ten inches across. Among the hundreds of varieties found in China is a tree peony with yellow flowers.

The tree peonies are tender and require protection from winter cold. Soft-stemmed peonies grow each year from the roots. New plants will grow from cuttings taken from the base of the plant in autumn or spring. New varieties must be grown from seed after cross-pollination.

Scientific name of common peony, *Paeonia officinalis;* white Siberian peony, *P. albiflora;* tree peonies grown in America, *P. suffruticosa, P. lutea.*

How PEOPLE LIVE *Around the* WORLD



On this quarter of the globe are pictured some of the ways people live in different lands and climates. Along the equator are shown ways in hot, wet lands. Just above are a herder and an irrigation farmer in hot, dry lands. Next we see olive picking in a Mediterranean land, a mountain dairy farm, and factories in industrial western Europe and across the Atlantic in America. Along the Arctic Circle are a Lapp reindeer herder, a deep-sea fishing boat from Iceland, and an Eskimo hunter.

PEOPLE OF MANY LANDS. All people need food to eat, clothing to wear, and homes for shelter. All must communicate with one another and transport goods. People everywhere like to laugh and to play games. They need religion, education, government.

In all these ways people are much alike, wherever they live on the earth. But peoples of different lands use varied methods of meeting their needs. This is, in part, because one group lives in different surroundings from another. Some people live in cold lands and some in hot. Some places are rugged and mountainous—others low and level. Heavy rains may drench one region while another is dry for a season or for the whole year.

In a hot, rainy land, for instance, people wear fewer clothes than those in a cold land. In a dry place, people may build a house from material that would quickly wash away in a rainy region. The principal food of one group may be rice, because the rice plant grows well in their warm, moist homeland. In

cooler places, the farmers may grow and eat potatoes or wheat.

The nature of the people also influences their ways of living. People differ in education, in skills, in standards, and in other ways. In some places, the people get little or no schooling. A man can be proud of his skill if he can hollow a good canoe from a log. But he cannot carry much or go far. His family may be hungry when food is plentiful 50 miles away. In other countries the people have been trained in scientific methods. They can build ships and trains run by powerful engines. They can send away the things they grow or make, and trade them for the food or other goods they need.

Differences in the United States

Even in the United States, people's ways differ from place to place. In Maine, farmers raise potatoes and other hardy crops in the short, cool summers. Their fields are covered with snow in winter. The children may ski, coast on sleds, or skate for recreation. In Florida, many people tend fruit groves where they can pick oranges and grapefruit in the warm winter. They can swim, sail, bask in the sun, and play tennis in winter.

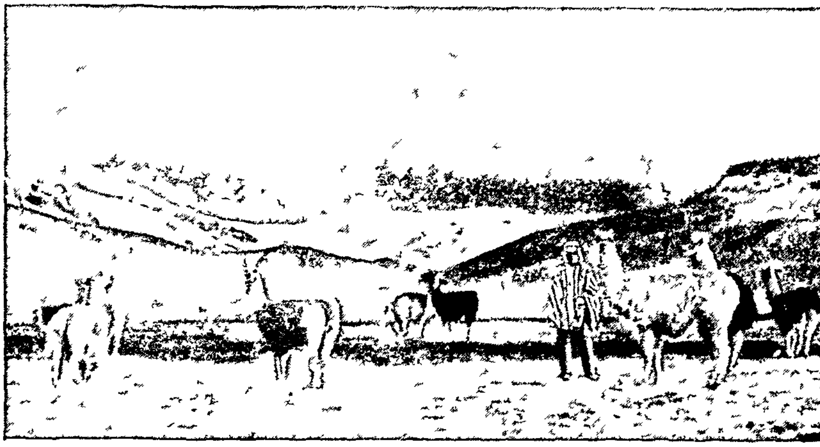
In states with plentiful rainfall, such as Indiana and Illinois, the farmers grow big crops of corn and wheat. Arizona and Nevada, on the other hand, have spots too dry for plants. In other sections, there are enough grass and shrubs to permit people to make a living by pasturing sheep, goats, or cattle.

Level land and fertile soil also help make Indiana and Illinois good places for farming. In mountainous and hilly states, the people may find stock raising better than farming. Some mountains hold veins of coal or ore and are covered with tall trees. The people may make a living by mining or logging. The United States article tells how resources and conditions in various sections influence ways of making a living.

Likenesses among Americans

The differences in ways of living in various parts of the United States are balanced by likenesses. All Americans have much in common. Their schools have given them chances to gain scientific understandings and skills. They have developed a net-

FOUR WAYS PEOPLE GET THEIR FOOD



This snow-rimmed valley in the Andes Mountains of South America is too cold, rugged, and dry to farm. Indian herders pasture llamas on the coarse grass. The llamas furnish them meat, milk, and wool and carry their loads.

These Alaskan Eskimos (left) are taking fish from the frozen sea. They wear clothes made from skins of Arctic animals the hunters have killed for food. Here a native woman (right) on a hot, rainy Pacific Island is harvesting a food plant—taro. Notice the stumps left standing in her garden and the fence made of poles.

Workers on an irrigated California truck farm are using a digging machine pulled by a tractor to harvest a big carrot crop. Beyond them are boxes for shipping the carrots to distant markets and a trailer home used by workers.

work of transportation, communication, and trade. Trucks and trains carry products across the land, and stores and offices sell them. Instead of depending upon their locality to provide the things they need, the people sell their crops, coal, lumber, or factory goods to others, and buy what they need from other places. As a result Americans in all sections eat the same foods and use many of the same products. They are unified by reading the same books, magazines, and newspapers; enjoying the same radio, television, and theater programs; attending the same churches; and living under one government.

How Foods Differ Around the World

An example of differences in foods and other products enjoyed by various peoples is seen in the use of milk. In the United States and Canada most boys and girls drink pure, fresh milk each day (*see* Milk).

Children in some other parts of the world do not know the taste of cow's milk. In crowded China, land cannot be spared for pasturing cows and raising hay and grain for them. In the steaming rain forest along the Congo River in Africa, cattle cannot stand the heat and the bite of the tsetse fly. In many other lands, the people long ago learned to make cheese from milk, and they prefer it to fluid milk.

Understanding Peoples and Their Lands

MANY such examples could be given to show that we cannot understand a people's ways unless we know about their land and climate. We should also know about their training, education, standards, and beliefs.

For the most part we find that customs and ways of living are reasonable for a people and their land. A way that seems strange and backward at first may turn out to be better suited to a place and people than up-to-date customs found elsewhere.

How Eskimos and Lapps Live in a Cold Climate

The Eskimos know how to meet their needs where living is difficult. They live north of the United States. Some of them dwell within the Arctic Circle. Winter is long, cold, and dark there. Crops and forests cannot grow. The Eskimos long ago learned to depend on Arctic land and sea animals, birds, and fish. The men became expert hunters and brought in meat to eat. The women found out how to turn the furry animal skins into clothing far warmer than the cotton and woolen clothes of Americans. They use skins, earth, rocks, and even snow to build houses. For centuries the Eskimos lived without getting anything from other lands. Today they trade furs for a few supplies that white traders bring in by ship or airplane.

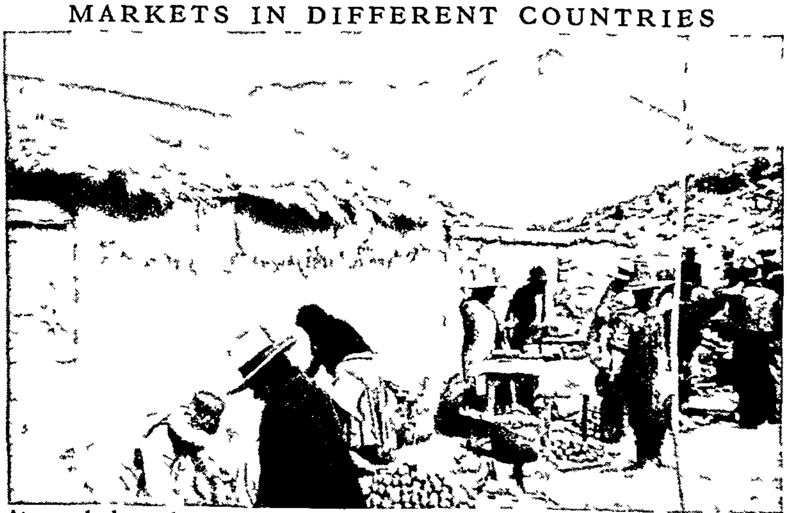
The Eskimo article tells about their ways of living. The Arctic Regions article describes the land, and the Earth article explains why it is so dark and cold in winter.

The Lapps of northern Europe also live in a cold land. But they do *not* have to depend upon hunting, because long ago they learned to tend herds of reindeer. These hardy animals roam about cropping plants that grow in the chill ground. The Lapps follow them about. They depend upon the reindeer for food, leather and transportation. In the towns of Lapland, they barter the hides for wool cloth for clothing and tents, tools, utensils, and other supplies. (*See also* Lapland; Reindeer.)

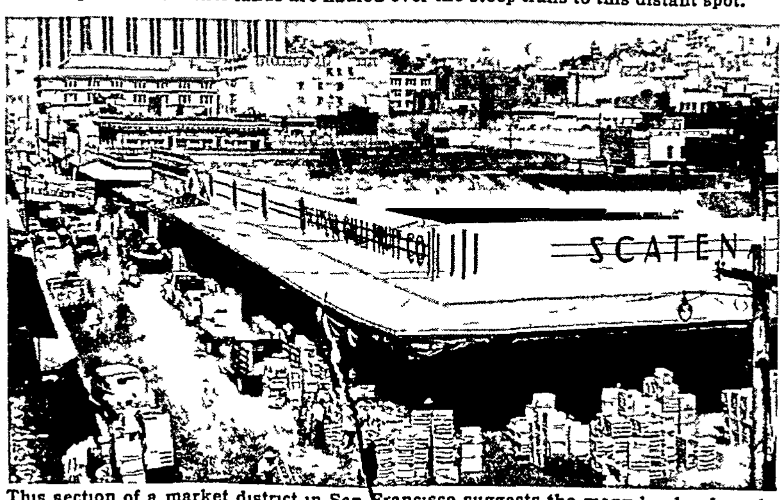
A Contrasting Way of Life in Iceland

The island Iceland lies in the North Atlantic as near to the North

MARKETS IN DIFFERENT COUNTRIES



At a roadside market in the mountains of Bolivia, the Indians offer their potatoes for sale. There is little they can buy except things raised or made by their neighbors. Few products of other lands are hauled over the steep trails to this distant spot.



This section of a market district in San Francisco suggests the many kinds of goods Americans can buy. Growers and manufacturers from all parts of the world send produce in by ship, train, and truck. Here, as in other modern trading nations, the people earn money to buy goods instead of raising or making what they need.

GAMES PLAYED BY BOYS AND GIRLS OF MANY LANDS


Children everywhere love to play. The games above are known to youngsters around the world. The Dutch girls (left) join hands in one of the common circle games, such as "Drop the Handkerchief." The Mexican boys (right) are playing with jacks.


These boys have made up games to imitate their fathers' work. The sons of a reindeer herder in Lapland (left) play "reindeer roping." At the right, thinly-clad tots in a hot, wet land pretend they are hunters bringing in a pig for a feast.

Pole as parts of the Eskimo homeland. But life is very different in Iceland. The climate is warmer along its coasts because the island is swept by warm ocean currents. It was settled by people from northern Europe about 1,000 years ago. These settlers were educated, and experienced in farming, stock raising, seamanship, and other skills the primitive Eskimos and Lapps had never learned.

The Icelanders found that they could raise a few hardy crops on the best land and pasture cattle, ponies, and sheep on the fine grass. But the sea offered more than the land. Fishing soon became and remained the leading industry and work of the people. Instead of depending on what they raise and make at home, the Icelanders ship their huge catches of fish abroad and buy products they need (*see* Iceland).

Ways of Living in Europe

The continent of Europe has a variety of lands and climates. Temperatures grow warmer southward from Lapland, and rainfall varies. The northwest coast gets a lot of moisture all year, but lands around the Mediterranean Sea have summer drought. Kinds and altitudes of land range from flat plains below sea level in the Netherlands to rugged ridges and peaks in the Alps (*see* Europe).

In the course of their history the people of each region have worked out ways of living suited to the land, climate, and resources. Long ago they learned to cultivate crops suited to their climate, to raise stock on rough or poorly drained land, to get fish from the sea, and to provide lumber or stone for their houses. But nowhere were the people content merely to meet their bare needs. They developed resources of their lands to get products to trade or raw materials to manufacture. Commerce and industry provided work for growing populations. They linked the regions with waterways, railways, and roads to transport goods and people. They made scientific and technical discoveries that transformed industry. They created beauty in architecture, art, and literature.

Articles on the various countries describe their people's ways and achievements.

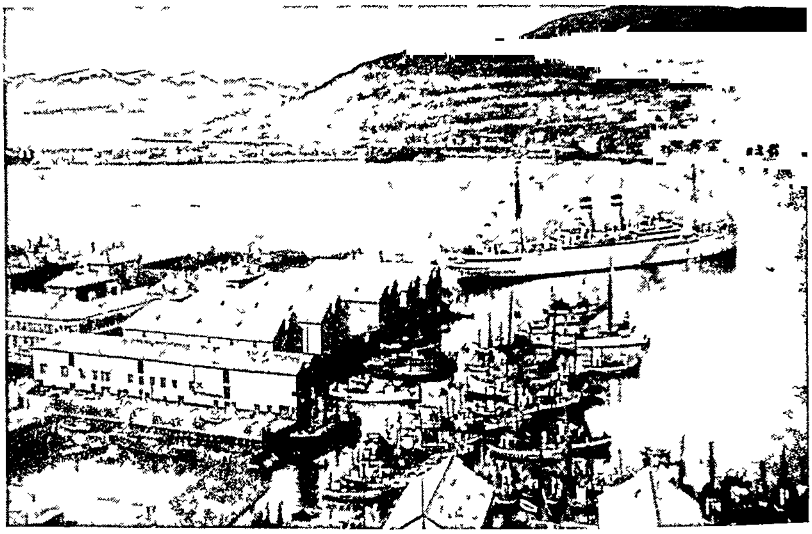
The Norway article deals with a people in a cool highland by the sea. It describes the thrifty ways of the farmers who overcome the handicaps of rugged land and a short growing season. It tells how the Norwegians turned to a sea that was richer than the land and gained wealth through fisheries, ocean shipping, and foreign trade.

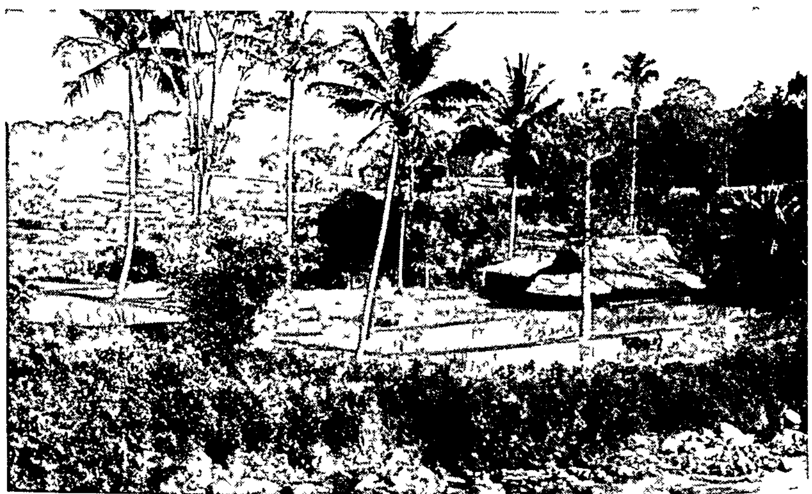
The Netherlands article deals with a low, level, fertile land with a favorable growing season. But the Dutch people had to build great dikes to hold back the sea and canals to drain the land before they could develop their agriculture, commerce, and manufacturing.

The Switzerland article tells of a beautiful mountain land without a seaport. Lands of this kind may not be developed because it is hard to farm and to build roads and railroads there. But the Swiss made their high homeland in the heart of Europe into a rich manufacturing country, a tourist playground, and a peaceful, respected nation.

The lands beside the Mediterranean Sea in southern Europe have a special type of climate, with hot, dry summers and rainy winters (*see* Climate). This kind of climate is called Mediterranean even in southern California or central Chile. Europe's first great civilizations grew up here in ancient Greece and Rome. Their land is rugged and dry, but most of the people make a living by farming. They build mountainside terraces for vineyards, fruit, and olive groves. They irrigate the soil when they can get water. The articles on Greece and Italy describe two of these countries and their people.

LEARNING ABOUT LANDS FROM PICTURES





Students can learn much about lands and peoples from these and other pictures by seeking answers to such questions as these What are the people doing? What does the picture suggest about the climate? About the kind of land? Where on the globe might places like these be found? What materials are used in homes or buildings? Do the pictures suggest where the builders get the materials? What would seem to be favorite foods here? What means of transportation can be seen? Do the people trade with other lands? What may they sell?

Living in a Hot Desert Land

A hot, dry land is a difficult place for plants, animals, or people to live. The largest region of this kind stretches south and east of the Mediterranean Sea, along both sides of the Tropic of Cancer. Here lie the Sahara and Arabian deserts. So little rain falls that nothing grows over mile upon mile of rock and drifting sand. In some areas, especially along the desert's edge, rough grass and shrubs spring up where rain has fallen or where there is underground water.

Places where underground water is plentiful are called *oases*. The people build towns at the oases. They construct houses of sun-dried mud bricks, with thick walls to keep out the heat. They dig wells and use the water to irrigate vegetables, fruits, and grains Palms offer sugary dates and a bit of shade.

In the oasis market place, or bazaar, the farmers trade with herding people from the desert. These wandering herders, or *nomads*, pasture their flocks wherever they can find plants. They move every few days as the grass is eaten. They live in tents made from the wool of their sheep or camels and carry their supplies on the camels (*see* Nomads; Deserts).

Where rivers from rainier regions flow through a desert, huge areas may be irrigated. The Nile Valley of Egypt has been called a vast oasis. The Egypt article tells how its people live and cultivate the soil

Living in Cool and Hot Grasslands

The desert nomads live somewhat like the Lapp reindeer herders. There are many other parts of the earth where herders follow grazing animals. Vast areas in

the mountains of central Asia are too rugged and dry for farming. People here pasture cattle, horses, sheep, and goats. Some also raise two-humped camels and other hairy beasts, called *yaks*. The article Mongolia tells how one of these nomadic peoples, the Mongols, live. (*See also* Grasslands.)

In other cool grasslands the people live more as ranchers do in western United States. The rancher owns hundreds or thousands of acres of grazing land. If he must send his flocks or herds to other pasture for a season, he hires cowboys or sheepherders to look after them. The family stays at the ranch house. Ranches are called *estancias* in Argentina and *cattle stations* or *sheep stations* in Australia.

In the Sudan, south of the Sahara in Africa, stretch hot grasslands. During the rainy season from May to September they get enough moisture for grass, or for grass and scattered bushes and trees. In the Africa article the vegetation map locates these grassy *savannas*. The color picture shows some of the wild animals that crop the grass and shrubs.

The Negro people of the hot grasslands keep herds of cattle. They must guard them by day and pen them behind a high brush fence at night to protect them from the lions that prey on the grazing animals. During the rainy season, the people raise crops of corn, sorghum, and millet for their bread.

Living in Hot, Rainy Lands

Hot, rainy lands lie on and near the equator. Tropical trees grow in dense rain forests there. It is hard to travel through the thick growth and hard to clear the land. Some peoples in these forests live by hunting and gathering wild nuts, berries, roots, and leaves. Others clear a patch of ground and raise food plants. When the heavy rains wash away the plant food, they must clear a new garden. In the forest they find slender trees for a house frame and leaves for thatching it. They make steep roofs to shed the rain. (*See also* Congo River; Amazon River; Malay Peninsula.)

In the islands of the East and West Indies and the South Pacific, as well as some other tropical lands, people work on big plantations growing tropical crops. These lands ship rubber, rice, sugar, pineapples, bananas, coffee, tea, and spices to cooler parts of the world.

In some of the tropical lands, high mountains keep the climate much cooler than in the lowlands. Most of the people choose the highlands for their homes. The Bolivia article tells how the people live by farming, by pasturing llamas, alpacas, and sheep, and by mining the tin found in the mountains.

Farming in Ancient Lands of Asia

The ways of the people in the crowded lands in many parts of Asia seem strange to Americans. These lands are fertile, well watered, and good for farming. However, they are so crowded that it is difficult for the people to get enough to eat. Long ago they worked out careful ways for meeting their needs, and they have changed these ways very little over the centuries. Where it is warm enough they raise rice as their principal food (*see* Rice). They do most of their work by hand with crude tools. The articles on China and India tell how the people live in two of these ancient lands.

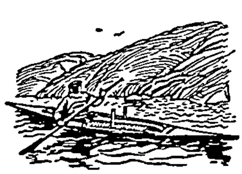
WHERE TO FIND MORE ABOUT PEOPLE OF MANY LANDS

ARTICLES on the many countries and regions of the earth tell about their land and peoples. From them we learn how the people use the land and its resources in making a living, how they build their houses, what they eat, what they wear, how they travel, transport goods, and communicate with one another. We find out about their strange and interesting customs and festivals and about their religion and government. In most articles, a heading **How the People Live** guides the reader to this information. Pictures illustrating everyday activities of the people are especially useful.

Other articles deal with the crops the people raise, the animals they depend upon, and their special industries.

I. To find out how the people live in a cold, northern land

- **A. Read about the Eskimos** E-393-7 (this means volume D-E, pages 393-7)
  —Think about why Eskimos wear clothing made from animal skins



- **B. Read about Lapland and the Lapps** L-101-2: reindeer R-97
  —Think about why reindeer herding is a surer way of making a living than hunting
- **C. Read about Iceland and the Icelanders** I-9-12
  —Think about what the Icelanders can sell to people of other lands

II. To find out how people live in a cool highland by the sea

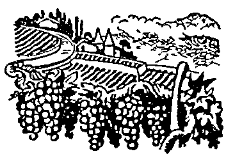
- **A. Read about Norway and the Norwegians** N-302-4*b*: Northmen N-294-7
  —Think about why the Norwegians have been famous seamen throughout the many centuries of their history
- **B. Read about Sweden and the Swedes** S-462-5
  —Think about how the Swedes make their rivers help develop their lumbering and mining industries
- **C. Read about Alaska and the Alaskans** A-132-7
  —Think about why the chief cities lie along the southwest coast

III. To find out how people live in a temperate, or middle latitude, lowland by the sea

- **A. Read about the Netherlands and the Dutch** N-117-20
  —Think about why wooden shoes are sensible footwear for Dutch farmers
- **B. Read about Belgium and the Belgians** B-110-14
  —Notice the canals on the map of Belgium and the Netherlands on page B-111. In what two ways are they used?

IV. To find out how people live in a mountain land without a seacoast
   A. Read about Switzerland and the Swiss S-474-7: cheese C-206-7
   B. Read about the Rocky Mountain states in the United States U-295, 298
      —Which of the following statements apply (1) to the Swiss; (2) to people of the Rockies; (3) to both peoples? "Minerals are a chief source of their wealth." "They have many factories." "They take the cattle to the high pastures in summer."

V. To find out how people live in a land with a Mediterranean climate
   A. Read about Greece and the Greeks G-189-91
      —Think about why olive trees and grapevines are widely grown in lands with hot, dry summers and cool, rainy winters
   B. Read about Italy and the Italians I-264-9
      —Give reasons why Mediterranean farm people generally live in villages of stone and stucco houses



   C. Read about southern California C-39-41
      —Think about how the irrigated farms here are similar to and different from those in European lands with a Mediterranean climate
   D. Read about central Chile C-252-3
      —Think about which are the winter months when Chile's Central Valley gets rain

VI. To find out how people live in hot, dry lands
   A. Read about the nomads of Arabia and the Sahara *N-242-242b, A-285-8, S-16: camel* C-50-3; goats G-128-9; sheep S-136
      —Think about why wandering herders live in tents
   B. Read about Egypt and its Nile Valley farmers E-272-6
      —Think about why Egyptians live in mud-brick houses with flat roofs
   C. Read about the Southwest Indians I-104*c*-6
      —Think about why the Navajos have more than one home (hogan)
   D. Read about the outback in Australia A-482-4
      —Think about why some of the sheep stations are as big as an American state

VII. To find out how people live in grasslands
   A. Read about Mongolia and the Mongolians M-342-4
      —Think about why the Mongolians make their tents (yurts) from felt

   B. Read about the Great Plains of North America U-291-3: cattle C-147-55
      —Think about why farmers plant grain on grazing lands in some years but not in others
   C. Read about the Argentine pampa A-330-2 S-262
      —What Americans do the gauchos resemble?

VIII. To find out how people live in hot, wet lands
   A. Read about the Congo basin C-434-434*c*
      —Think about why the dugout canoe is the leading native means of transportation
   B. Read about the Amazon River and basin *A-184-6, S-261-2*
      —Think about why it is hard to raise a garden here
   C. Read about the peoples of Malaya M-57-60: rubber R-238-9
      —Think about how the Semang of the jungle get food without raising crops or animals
   D. Read about the Philippine Islands P-194-9: coconut palm C-374-6
      —Think about how the Filipino farmer gets free materials to build a house

   E. Read about the East Indies E-204-7, J-326, B-254-5
      —Think about why crops grown on native farms differ from those grown on estates
   F. Read about Indo-China I-123-4: rice R-147
   G. Read about the Hawaiian Islands H-288*a*-289: sugar S-443; pineapple P-259
      —Think about why Hawaiians learn to swim and canoe very young
   H. Read about the Pacific Islands P-3-9: Tahiti T-5-6

IX. To find out how people live in cool highlands amid tropical lowlands
   A. Read about Bolivia B-222*a*-4, S-263-4: llama L-285; alpaca A-176
   B. Read about the ancient Inca Empire I-50
      —Think about why population has been greater in the highlands than in the lowlands both in ancient and in modern times
   C. Read about the rugged lands of tropical North America: Mexico M-188-200; Central America C-171-6; Guatemala G-222-222*d*; coffee C-378-9; bananas B-43-5

X. To find out how people live by ancient customs in crowded agricultural lands
   A. Read about China C-258-75: tea T-29
      —Think about kinds of work done by the Chinese people that would be done by power machinery in America

   B. Read about India I-56-62
      —Think of ways the climate, overpopulation, and religious beliefs cut down the food supply in India

XI. To find out about differences in kinds of lands and climates, read about the following: the earth E-172-90; climate C-348-51; winds W-150-5; rainfall R-70-2; seasons S-91-2; soils S-226-31; grasslands G-168*b*-170; deserts D-73-73*b*

XII. To find out how these differences influence ways of living, read about the following: the world W-201-2; geography G-39-44; ecology, E-212-22; shelter S-142, pictures S-144*b*; clothing C-354; food F-210-17; transportation T-170*b*-*c*

PEORIA, ILL. From a small French trading post on the Illinois River, Peoria has grown to be the second largest city in Illinois. Located in the heart of the corn belt, it is a center of trade, transportation, and industry.

The river is now a major link in the Great Lakes to Gulf Waterway. A river-rail terminal joins it with the region's railway network. The city is noted for its manufacture of tractors and its huge distilling and brewing industries. Other leading plants make earth movers, farm machinery, wire products, and chemicals. An agriculture research laboratory develops new uses for farm products.

The residential district is built on a high bluff and overlooks the factories below. Grand View Drive, a three-mile scenic highway, is part of a park system of more than 1,600 acres. Lake Peoria, a basin of the Illinois River, provides boating and other water sports. Another point of interest is Bradley University.

Peoria was first settled by the French in 1691. It is sometimes called the state's oldest city, although settlement was not continuous after that date. Fort Clark, built here by Americans in 1813, was renamed for the Peoria Indians. Chartered in 1845, the city replaced its mayor-council government with a city manager in 1952, effective in 1953 Population (1950 census), 111,856.

A YOUNG PEPPER GARDEN

Pepper shrubs climb like ivy over the wooden poles which support them (top picture) The lower picture shows the plant's oblong leaves and spikelike clusters of fruit. The fruit is green at first, then it becomes yellow. When it is ripe, the fruit turns red.

PEPPER. Commonest and most important of all spices, pepper ranks next to salt as a seasoning for food. But in the western lands of ancient and medieval times, only the rich could afford to use it. The supply came by caravan from the Far East at great cost. One pound was considered a fitting present for a king.

Taxes and tribute were often paid with pepper. When soldiers in victorious armies received their shares of the spoils, pepper would be a valuable part of the reward. One of the reasons the Portuguese sought a sea route to India was to obtain a less costly supply of pepper. After they found the way around the Cape of Good Hope, the cost of pepper in Europe fell considerably.

Today pepper costs so little, we think scarcely anything of it. The United States alone consumes about 15,000 tons a year. Cheap transportation by steamer has made the difference, because the supply still comes from the Far East.

Origin and Cultivation of Pepper

Pepper comes from the fruit or seeds of a climbing shrub, which originated in the Malabar district on the west coast of India. The present supply comes from India, Malaya, and Indonesia. Pepper will grow wild, but most of it is grown on plantations. Shrubs are grown from seeds or cuttings. They need trimming and fertilization, and underbrush must be cut away from the stalks. They yield fruit in three years, and reach full production in seven years.

Black pepper is made by picking unripe berries, drying them until black, and grinding them to powder. White pepper is made by removing the outer coat before grinding The scientific name of the pepper plant is *Piper nigrum.*

Other Plants Called "Peppers"

Other kinds of pepper are obtained from various plants of entirely different families. The most important are the red peppers, or chilies, of the tropical and temperate zones. These belong to the genus *Capsicum.* The fruit is used both green and ripe.

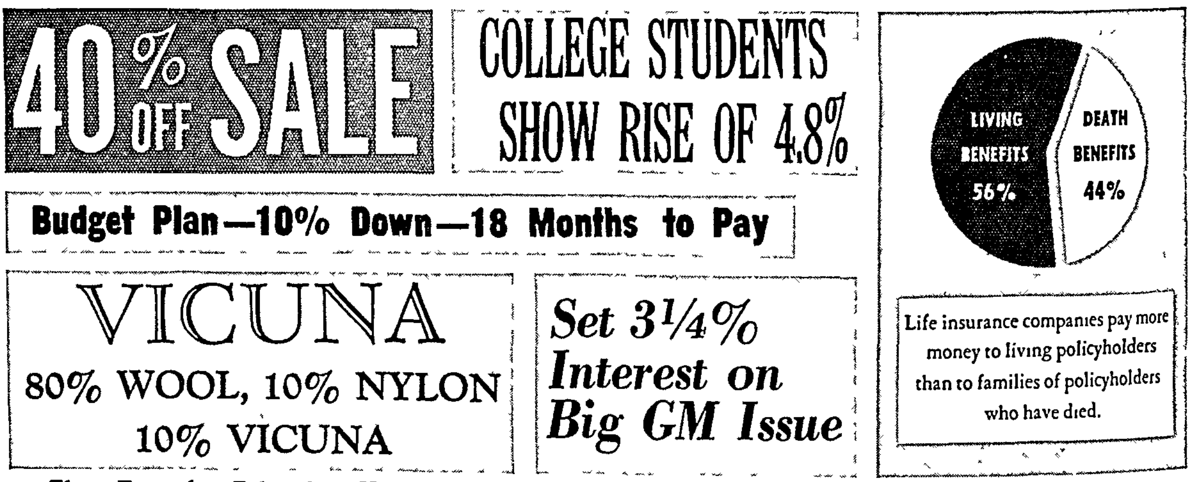
Some small varieties, such as cayenne peppers (named after the city of Cayenne, French Guiana) and tabasco peppers, are extremely pungent. The large "bell" peppers of the United States are unripe green peppers. They are agreeably mild. Stuffed with cabbage pickle they make "mangoes," a favorite relish in the United States. When bell peppers are ripe, they are red and hot but still milder than the small varieties. Canned in oil, they are called "pimientos," from the Spanish for "pepper plant." Stuffed olives usually contain ripe bell peppers saturated in olive oil. Paprika is a red pepper produced from

the dried pods of these mild sweet peppers and can be used far more freely than the pungent cayenne pepper. The so-called Jamaica pepper is not a true pepper but belongs to the myrtle family and is better known as allspice or pimento. (*See* Spices and Condiments.)

PEPSIN. One of the most important agents in the digestion of food in the stomach is pepsin. This is a ferment, or *enzyme*, believed to be secreted by glands in the mucous lining of the stomach (*see* Enzymes). It is found in the gastric juices of most vertebrates.

Pepsin has the power of digesting proteins (tissue-building foods such as lean meat, peas, and the white of egg), changing them into peptones which are soluble and thus capable of absorption in the alimentary canal. It is useless in the digestion of fats or carbohydrates. Its action is greatly stimulated by the presence of the hydrochloric acid, which is also secreted by the stomach (*see* Digestion).

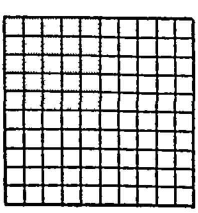
When the human digestive organs become disordered and the proper amount of pepsin is no longer secreted, pepsin is given as a medicine. Commercial pepsin is produced by drying the mucous membrane of the stomachs of pigs, calves, and sheep. It appears as a yellowish powder. It is an ingredient in most digestive preparations on the market. If a healthy stomach is dosed with such digestive preparations, it soon ceases to secrete its own pepsin—in accordance with the law of nature that an unused organ tends to disappear. Pepsin has been isolated in a crystalline state, but its exact chemical composition is unknown.



These Examples, Taken from Newspapers and Magazines, Illustrate Some of the Many Uses of Percentage

How to Figure PERCENTAGE *and* INTEREST

PERCENTAGE AND INTEREST. The square below is divided into 100 small squares. If we want to show the proportion of the shaded squares (25) to the whole square, we can do it in several ways. We may write the proportion as a common fraction ($\frac{25}{100}$ or $\frac{1}{4}$); as a decimal fraction (.25); or as a percentage (25%). Similarly, each of the 100 small squares may be designated as $\frac{1}{100}$, as .01, or as 1%. The sign % is read "per cent." The word *cent* is from the Latin word *centum*, which means "hundred." It is easy to understand percentage if we remember that *per cent* means hundredths.



Since per cent means hundredths, the whole is always 100% (100 hundredths). The whole square above is clearly 100% because it is divided into 100 equal parts. The whole square would still be 100%, however, if it were divided into only four parts, and the shaded area would still be 25%. The "whole," or "all" (100%), may be a pint of milk, 2 dollars, $2\frac{1}{2}$ yards of ribbon, 30 children, or the entire population of the United States.

Percentage is closely related to decimals and common fractions. The study of these subjects should therefore precede the study of percentage (*see* Fractions; Decimals).

Changing decimals to per cents. It is easy to change a decimal to a per cent when the decimal has two places. For example, .35 (35 hundredths) is 35%. If the decimal has only one place (tenths) we annex a zero to make two places. For example, .5 = .50 = 50%.

If there are more than two decimal places, we can express the per cent as a decimal mixed number (*see* Decimals), or we can round it to the nearest whole per cent, as we see fit. For example, .082 = 8.2%; and .8429 = 84.29%, or 84% approximately. We seldom use a common fraction to express less than 1 per cent unless the fraction has a small denominator. For example, we frequently express 12.5% as $12\frac{1}{2}$%, but we seldom express 20.44% as $20\frac{11}{25}$%.

Changing per cents to decimals. If we want to change a per cent to a decimal fraction, we simply drop the per cent sign and point off two decimal places. Thus, 85% = .85; 6% = .06. If the per cent is a decimal mixed number, we move the decimal point two places to the left. Thus, 37.5% = .375.

Changing common fractions to per cents. To change a common fraction to a per cent, we first change it to a decimal with two decimal places (hundredths), and then change the decimal to a per cent. For example, $\frac{1}{25} = .04 = 4\%$; $\frac{5}{8} = .625 = 62\frac{1}{2}\%$, or 62.5%.

The common fraction equivalents of all the following per cents should be recognized at once:

$25\% = \frac{1}{4}$	$60\% = \frac{3}{5}$	$87\frac{1}{2}\% = \frac{7}{8}$
$50\% = \frac{1}{2}$	$80\% = \frac{4}{5}$	$16\frac{2}{3}\% = \frac{1}{6}$
$75\% = \frac{3}{4}$	$12\frac{1}{2}\% = \frac{1}{8}$	$33\frac{1}{3}\% = \frac{1}{3}$
$20\% = \frac{1}{5}$	$37\frac{1}{2}\% = \frac{3}{8}$	$66\frac{2}{3}\% = \frac{2}{3}$
$40\% = \frac{2}{5}$	$62\frac{1}{2}\% = \frac{5}{8}$	$83\frac{1}{3}\% = \frac{5}{6}$

Changing per cents to common fractions. To change a per cent to a common fraction, we first change it to a decimal. Then we change the decimal to a common fraction and reduce the fraction to its lowest terms. For example, $75\% = .75 = \frac{75}{100} = \frac{3}{4}$.

There are not many per cents in the form of mixed numbers which we would want to change to common fractions. Those included in the above list occur frequently and should be memorized.

Finding a per cent of a number. A teacher knows that 5 per cent of his salary will be withheld for his retirement allowance. What amount will be withheld for this purpose if his salary is \$4,200 a year? Since per cent means hundredths, 5% of \$4,200 is .05 of \$4,200. To find .05 of \$4,200, we multiply \$4,200 by .05 (Example A). We see that the amount to be withheld for a retirement allowance is \$210.

A
$$\begin{array}{r} \$4200 \\ .05 \\ \hline \$210.00 \end{array}$$

A plane fare is \$31.45 and the time-table states: "Fares are subject to 10% United States government tax." If a round-trip ticket is purchased, a discount of 5% is allowed. What is the cost of a round-trip ticket, including the tax?

Without the discount or tax, the round-trip fare would be 2 × \$31.45, or \$62.90. To find the amount of the discount, we find 5% of \$62.90 (Example B). This is \$3.1450; but since fractions of a nickel are ignored, the actual discount is \$3.10. Subtracting \$3.10 from the round-trip fare without the discount (\$62.90−\$3.10) we find the round-trip fare without tax to be \$59.80. The tax is 10% of \$59.80, or \$5.98, or \$6.00. The passenger pays \$59.80 + \$6.00, or \$65.80, for a round-trip ticket with tax.

B
$$\begin{array}{r} \$62.90 \\ .05 \\ \hline \$3.1450 \end{array}$$

RULE. Finding a per cent of a number is simply a matter of changing the per cent to an equivalent decimal fraction or common fraction and then multiplying the number by this decimal or fraction.

Finding what per cent one number is of another. Carl spelled correctly 17 of the 20 words in a spelling test. To find what per cent of the words he spelled correctly we first think: he spelled $\frac{17}{20}$ of the words correctly. We then change $\frac{17}{20}$ to a decimal, as shown in Example A. We divide 17 by 20 because 17 is $\frac{17}{20}$ of 20. Then we change the decimal to a per cent. We see that Carl spelled .85, or 85%, of the words correctly.

A
$$\begin{array}{r} .85 \\ 20\overline{)17.00} \\ 16\ 0 \\ \hline 1\ 00 \\ 1\ 00 \\ \hline \end{array}$$

A basketball team played 15 games and won 9 of them. What per cent of the games played did they win? We find what per cent 9 is of 15 (Example B). The quotient is seen to be .6. But per cent means hundredths. Since we must have two decimal places to express hundredths, we annex a zero to .6, making it .60. This team won .60, or 60%, of its games.

B
$$\begin{array}{r} .6 \\ 15\overline{)9.0} \\ 9.0 \\ \hline \end{array}$$

Baseball standings and other sports records are usually expressed to three decimal places. The resulting three-place decimal is often called a per cent and is indicated in a table by the letters PC, although strictly speaking it is not a per cent. Per cent means hundredths, not thousandths.

In one season, a certain baseball player was at bat 445 times and made 138 hits. To find this player's batting average for the season, we divide 138 by 445 and express the quotient to the nearest thousandth (Example C). The quotient is .310. This player made hits 31.0% of the times he was at bat. Baseball statistics would give this player's batting average as .310, not as 31.0%. His average would be read as "three hundred ten."

C
$$\begin{array}{r} .310 \\ 445\overline{)138.000} \\ 133\ 5 \\ \hline 4\ 50 \\ 4\ 45 \\ \hline 50 \end{array}$$

RULE. To find what per cent one number is of another, we first note what fractional part it is and then change the fraction to a decimal and to a per cent.

Finding a number when a per cent of it is known. A man wants to have 200 chickens to take to market. He has learned from past experience that approximately 80% of the chicks he buys will live. How many chicks should he buy?

80% of the chicks to be bought = 200
1% of the chicks to be bought = $\frac{1}{80}$ of $200 = 2\frac{1}{2}$
100% of the chicks to be bought = $100 \times 2\frac{1}{2} = 250$.

As a check, we note that 80% of $250 = .80 \times 250 = 200$.

Most merchants follow the practice of computing the per cent of profit as a per cent of the selling price and not as a per cent of the cost. Suppose that an article costs \$5.00 and the expenses of selling it amount to \$1.00. A profit of 25% on the selling price is desired. What should the price be? Since 25% of the selling price is to be profit, 75% of the selling price is equal to the cost plus the expense of selling, or \$5.00+\$1.00, or \$6.00. Then,

75% of the selling price = \$6.00
1% of the selling price = $\frac{1}{75}$ of \$6.00, or \$.08
100% of the selling price = 100 × \$.08 = \$8.00

As a check, note that 75% of \$8.00 = .75 × \$8.00 = \$6.00

Simple and Compound Interest

Simple interest. A common use for percentage is in computing interest on money borrowed. *Interest* is money paid for the use of money. The amount bor-

rowed is called the *principal.* The per cent charged as interest is called the *rate.*

Ray James, a farmer, borrowed $600 from a bank to buy fertilizer and seed. He agreed to pay interest at the rate of 5% a year. The amount of interest

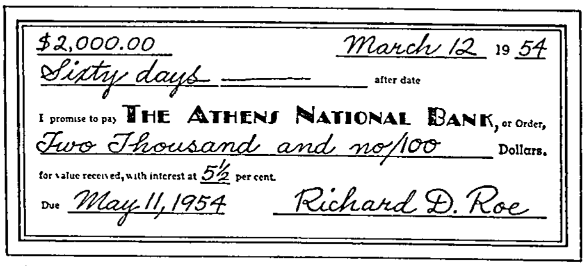
A

$$\begin{array}{rl} \$600 & = \text{the principal} \\ .05 & = \text{the rate} \\ \hline \$30.00 & = \text{interest for 1 year} \end{array}$$

charged depends upon the length of time the borrowed money is kept. If Ray James keeps the $600 for one year, the interest charge will be 5% of $600, or .05×$600, or $30.00 (Example A). If he repays the loan at the end of six months, the interest charge will be only one half of $30.00, or $15.00, because six months is one half of a year. Of course, the interest for two years is two times the interest for one year.

In some business transactions, borrowed money is repaid within a few days. To compute the interest charge, we must find what part, or fraction, of a year the number of days is. In finding this fraction, we consider a year to be 360 days instead of 365 or 366, because the number 360 gives easier fractions to work with.

A PROMISSORY NOTE


$2,000.00 March 12 19 54
Sixty days after date
I promise to pay THE ATHENS NATIONAL BANK, or Order,
Two Thousand and no/100 Dollars.
for value received, with interest at 5½ per cent.
Due May 11, 1954 Richard D. Roe

When a person borrows money, he usually signs a promissory note. This is a written promise to pay a specified sum of money to a designated person or bank on a certain date or on demand.

Richard Roe borrowed $2,000 for 60 days from the Athens National Bank and agreed to pay interest at the rate of 5½% a year. The interest for one year ($110) is found by multiplying $2,000 by 5½%, or .055 (Example B). The time of the loan is 60 days, or $\frac{60}{360}$, or $\frac{1}{6}$ year. To find the interest for 60 days, we divide $110, the interest for one year, by 6. The interest for 60 days is $18.33.

B

$$\begin{array}{r} \$2000 \\ .055 \\ \hline 10000 \\ 10000 \\ \hline \$110.000 \end{array}$$

$$\begin{array}{r} \$18.33 \\ 6\overline{)\$110.00} \end{array}$$

Bank discount. Banks frequently subtract the interest from the face of the note before giving the money to the borrower. The interest subtracted is called *bank discount.* The borrower receives the difference between the face of the note and the discount. This is called the *proceeds.* If Roe's note had been discounted, the bank would have subtracted the interest ($18.33) from the face of the note ($2,000), and Roe would have received $1,981.67 as the proceeds. On the due date Roe would pay only the amount of the face of the note, $2,000, instead of $2,018.33. The amount of interest is the same either way but the *rate* is somewhat higher on the discounted note because the sum received by the borrower is smaller.

Interest on bonds. Corporations and governments borrow money by issuing bonds (*see* Stocks and Bonds). A bond is a written promise to repay the principal on a given date, usually many years later, with interest at stated amounts and periods.

The sum of money borrowed is written or printed on the face of the bond. This sum is called the *face value,* or *par value.* If a bond can be bought for less than its face value, the bond is said to sell *below par,* or *at a discount.* Thus, a $1,000 bond which can be bought at 95 could cost only 95% of $1,000, or $950. If the market value of a bond is greater than the face value, the bond sells *above par,* or *at a premium.* Thus, if a $1,000 bond is quoted at 105, the cost would be 105% of $1,000, or $1,050.

A

$$\begin{array}{r} .042 \\ 950\overline{)40.000} \\ 38\,00 \\ \hline 2\,000 \\ 1\,900 \\ \hline 100 \end{array}$$

The rate of income on a bond, called the *current yield,* depends upon the price paid for the bond. For example, the annual interest on a $1,000 4% bond is 4% of $1,000, or $40. If the cost of this bond is $950, the current yield is found by dividing $40 by $950 (Example A). The current yield is about 4.2%. On the other hand if the same bond costs $1,050, the current yield is found by dividing $40 by $1,050 (Example B). The current yield is about 3.8%.

B

$$\begin{array}{r} .038 \\ 1050\overline{)40.000} \\ 31\,50 \\ \hline 8\,500 \\ 8\,400 \\ \hline 100 \end{array}$$

When the $1,000 4% bond which is bought for $950 matures, an extra $50 will be gained. This $50 is the difference between the face value ($1,000) and the cost ($950). If the bond matures in 10 years, the average yearly gain is $5.00. Adding this $5.00 to the annual interest, $40, we have a total yield of $45 a year. Dividing $45 by $950, we obtain about 4.7%. This is called the *yield to maturity.*

If the bond costs $1,050 and matures in 10 years, an average *loss* of $5.00 a year will have to be absorbed because the owner will receive only $1,000 for his bond. This leaves a net yield of only $35 a year ($40−$5=$35). Dividing $35 by $1,050 we find that the yield to maturity is only about 3.3%.

Banks use special tables to determine yield to maturity on bonds bought at a discount or at a premium. These tables are based upon mathematical methods which are more exact than the method of calculation shown here.

Compound interest. So far, we have discussed *simple interest.* If the interest for a period is added to the principal and then the interest for the next period is calculated on the total, we have a *compound interest.* Interest may be compounded at the end of each year or for shorter interest periods.

Suppose that the Mutual Home and Savings Association pays interest on deposits at the rate of 4% a year. Each six months the interest is credited at the rate of 2%. On Jan. 2, 1954, Tom Jones deposited $1,000. If he does not deposit any more money or withdraw any money, the interest will be credited at the end of each six-month period and his account will appear as shown below. (The interest is calculated on the whole number of dollars only, the extra cents being ignored.) On Jan. 2, 1956, the total will be $1,082.42.

$1000 = principal, Jan. 2, 1954
.02
$20.00 = interest, July 1, 1954
1000.
$1020.00 = principal, July 1, 1954
.02
$ 20.40 = interest, Jan. 2, 1955
1020.
$1040.40 = principal, Jan. 2, 1955
.02
20.80 = interest, July 1, 1955
1040.40
$1061.20 = principal, July 1, 1955
.02
21.22 = interest, Jan. 2, 1956
1061.20
$1082.42 = Total, Jan. 2, 1956

Subtracting $1,000 from $1,082.42, we have $82.42, the compound interest on $1,000 for two years at 4%, computed semiannually. The simple interest on $1,000 for two years at 4% is only $80.00.

Calculating compound interest for many interest periods is a very tedious process. For this reason, compound interest tables are generally used. The table at the right shows the compound amount (principal plus interest) of $1.00 at various rates of interest for any number of periods from 1 to 50, inclusive. The table shows the compound amount of $1.00 for 35 years at 3% to be $2.8139, if interest is computed annually. The compound amount of $100 would be 100×$2.8139, or $281.39, to the nearest cent. As time goes on, compound interest rapidly runs ahead of simple interest. Simple interest at 3% on $100 for 35 years is only $105.

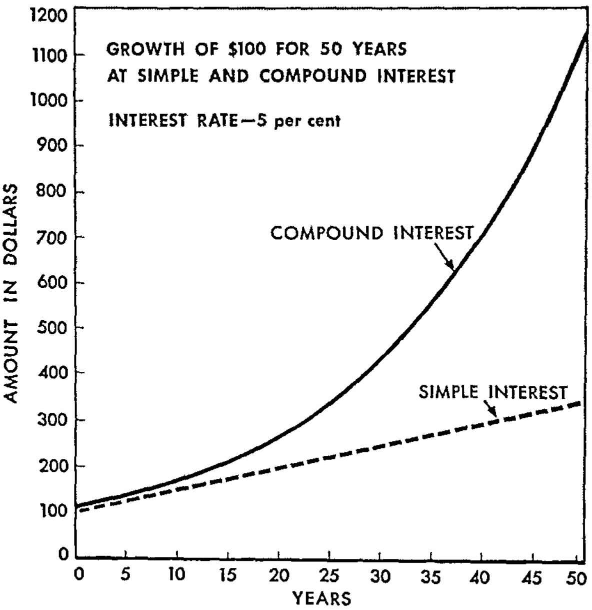
At compound interest computed annually, a sum of money will dou-

COMPOUND INTEREST TABLE

Compound Amount of $1.00 at Various Interest Periods

Periods	1%	$1\frac{1}{2}$%	2%	$2\frac{1}{2}$%	3%	4%	5%	6%
1	$1.0100	$1.0150	$1.0200	$1.0250	$1.0300	$1.0400	$1.0500	$1.0600
2	1.0201	1.0302	1.0404	1.0506	1.0609	1.0816	1.1025	1.1236
3	1.0303	1.0457	1.0612	1.0769	1.0927	1.1249	1.1576	1.1910
4	1.0406	1.0614	1.0824	1.1038	1.1255	1.1699	1.2155	1.2625
5	1.0510	1.0773	1.1041	1.1314	1.1593	1.2167	1.2763	1.3382
6	1.0615	1.0934	1.1262	1.1597	1.1941	1.2653	1.3401	1.4185
7	1.0721	1.1098	1.1487	1.1887	1.2299	1.3159	1.4071	1.5036
8	1.0829	1.1265	1.1717	1.2184	1.2668	1.3686	1.4775	1.5938
9	1.0937	1.1434	1.1951	1.2489	1.3048	1.4233	1.5513	1.6895
10	1.1046	1.1605	1.2190	1.2801	1.3439	1.4802	1.6289	1.7908
11	1.1157	1.1779	1.2434	1.3121	1.3842	1.5395	1.7103	1.8983
12	1.1268	1.1956	1.2682	1.3449	1.4258	1.6010	1.7959	2.0122
13	1.1381	1.2136	1.2936	1.3785	1.4685	1.6651	1.8857	2.1329
14	1.1495	1.2318	1.3195	1.4130	1.5126	1.7317	1.9799	2.2609
15	1.1610	1.2502	1.3459	1.4483	1.5580	1.8010	2.0789	2.3966
16	1.1726	1.2690	1.3728	1.4845	1.6047	1.8730	2.1829	2.5404
17	1.1843	1.2880	1.4002	1.5216	1.6528	1.9479	2.2920	2.6928
18	1.1961	1.3073	1.4282	1.5597	1.7024	2.0258	2.4066	2.8543
19	1.2081	1.3269	1.4568	1.5986	1.7535	2.1068	2.5270	3.0256
20	1.2202	1.3469	1.4859	1.6386	1.8061	2.1911	2.6533	3.2071
21	1.2324	1.3671	1.5157	1.6796	1.8603	2.2788	2.7860	3.3996
22	1.2447	1.3876	1.5460	1.7216	1.9161	2.3699	2.9253	3.6035
23	1.2572	1.4084	1.5769	1.7646	1.9736	2.4647	3.0715	3.8197
24	1.2697	1.4295	1.6084	1.8087	2.0328	2.5633	3.2251	4.0489
25	1.2824	1.4509	1.6406	1.8539	2.0938	2.6658	3.3864	4.2919
26	1.2953	1.4727	1.6734	1.9003	2.1566	2.7725	3.5557	4.5494
27	1.3082	1.4948	1.7069	1.9478	2.2213	2.8834	3.7335	4.8223
28	1.3213	1.5172	1.7410	1.9965	2.2879	2.9987	3.9201	5.1117
29	1.3345	1.5400	1.7758	2.0464	2.3566	3.1187	4.1161	5.4184
30	1.3478	1.5631	1.8114	2.0976	2.4273	3.2434	4.3219	5.7435
31	1.3613	1.5865	1.8476	2.1500	2.5001	3.3731	4.5380	6.0881
32	1.3749	1.6103	1.8845	2.2038	2.5751	3.5081	4.7649	6.4534
33	1.3887	1.6345	1.9222	2.2588	2.6523	3.6484	5.0032	6.8406
34	1.4026	1.6590	1.9607	2.3153	2.7319	3.7943	5.2533	7.2510
35	1.4166	1.6839	1.9999	2.3732	2.8139	3.9461	5.5160	7.6861
36	1.4308	1.7091	2.0399	2.4325	2.8983	4.1039	5.7918	8.1473
37	1.4451	1.7348	2.0807	2.4933	2.9852	4.2681	6.0814	8.6361
38	1.4595	1.7608	2.1223	2.5557	3.0748	4.4388	6.3855	9.1543
39	1.4741	1.7872	2.1647	2.6196	3.1670	4.6164	6.7048	9.7035
40	1.4889	1.8140	2.2080	2.6851	3.2620	4.8010	7.0400	10.2857
41	1.5038	1.8412	2.2522	2.7522	3.3599	4.9931	7.3920	10.9029
42	1.5188	1.8688	2.2972	2.8210	3.4607	5.1928	7.7616	11.5570
43	1.5340	1.8969	2.3432	2.8915	3.5645	5.4005	8.1497	12.2505
44	1.5493	1.9253	2.3901	2.9638	3.6715	5.6165	8.5572	12.9855
45	1.5648	1.9542	2.4379	3.0379	3.7816	5.8412	8.9850	13.7646
46	1.5805	1.9835	2.4866	3.1139	3.8950	6.0748	9.4343	14.5905
47	1.5963	2.0133	2.5363	3.1917	4.0119	6.3178	9.9060	15.4659
48	1.6122	2.0435	2.5871	3.2715	4.1323	6.5705	10.4013	16.3939
49	1.6283	2.0741	2.6388	3.3533	4.2562	6.8333	10.9213	17.3775
50	1.6446	2.1052	2.6916	3.4371	4.3839	7.1067	11.4674	18.4202

Interest for each period is added to the principal, and interest for the next period is calculated on the new total. If the period for which interest is calculated is a year, the interest is said to be compounded annually. If the period is six months, it is compounded semiannually. Quarterly and monthly periods are not uncommon.



Interest at 5% on $100 is computed at five-year intervals for 50 years. At the end of 50 years the amount at simple interest is $350, of which $100 is the original principal and $250 is the interest. In contrast, the amount at compound interest at the end of 50 years is $1,146.74, of which $100 is the principal. The lines would be much farther apart at 100 years. The amount at simple interest would then be $600 and the amount at compound interest would be $13,150.13.

ble itself at 3% in about 24 years; at 4% in about 18 years; and at 6% in about 12 years. From these facts a rough working rule has been formulated: To find the number of years in which a sum of money will double itself at a certain rate of compound interest, *divide 72 by the rate, ignoring the decimal point in the rate.* Thus, $72 \div 3 = 24$; $72 \div 4 = 18$; $72 \div 5 = 14+$; $72 \div 6 = 12$. These amounts agree closely with those in the table.

Index Numbers Are Per Cents

Index numbers are per cents without the per cent sign. They are used to compare groups of data that are otherwise difficult to compare and to measure their changes. Index numbers are used to show changes in living costs, in salaries and wages, and in quantities of goods produced.

In a certain college the average salary of all the teachers in 1945 was $2,933, and in 1955, $4,188. In the same college the average salary of all the janitors in 1945 was $1,148, and in 1955, $1,959. How does the average increase for the teachers compare with the average increase for the janitors?

If we subtract $2,933 from $4,188, we discover that the average increase for the teachers was $1,255. Subtracting $1,148 from $1,959, we find the average increase for the janitors to be $811. These increases are called the *absolute increases*. Clearly, the absolute increase for the teachers was greater than the absolute increase for the janitors.

But is an increase from $2,933 to $4,188 as great an increase proportionately as an increase from $1,148 to $1,959? To answer this question, we find what per cent $4,188 is of $2,933 and what per cent $1,959 is of $1,148. Dividing 4,188 by 2,933, we get a quotient of 1.43, to the nearest hundredth. On the average, the teachers' salaries increased 43%. The 1955 average is 143% of the 1945 average. This number, 143, without the per cent sign, is the *index number* for the teachers' salaries in 1955, using 1945 salaries as the *base* (100).

Dividing 1,959 by 1,148, we find that janitors' salaries increased on the average 71%. The 1955 average is 171% of the 1945 average. This number, 171, without the per cent sign, is the index number for the janitors' salaries in 1955, using 1945 salaries as the base.

Increases expressed in index number form are called *relative increases* because they are a proportion of a base amount which is accepted as 100%. The base can be a price or amount on a fixed date. It can also be an average price or amount over a period of time which is regarded as typical. Averages are the usual base for index numbers in business statistics. In such cases the index number shows relative change from an average of a period of time. The data are frequently presented in graphic form. (*See also* Statistics; Living Costs.)

PERCH. Of the many species of these spiny-finned fresh-water fish, the gamy yellow perch, a favorite of anglers, is the most plentiful and one of the most important commercial species. It abounds in the fresh waters of eastern North America, in the Great Lakes, and in the streams of the upper Mississippi Valley and has been introduced in western lakes and streams. Its back is olive green, the sides golden yellow, with six or eight dark bands, and the lower fins orange red. It reaches a length of one foot and a weight of two pounds. The eggs are deposited in strings which sometimes reach a length of seven feet. They are held together by a gelatinous substance and become draped over underwater plants and roots.

Yellow perch are sought in deep holes under shaded banks and about bridge piers, sunken timbers, and milldams. They can be taken with hook and line and with any sort of bait. They are carnivorous and feed on smaller fishes, including the young of some more valuable than themselves. They travel in schools and each school is composed of fish all of one size. In cold weather they become inactive. The yellow perch of Europe and Asia is closely related to the American species (scientific name, *Perca flavescens*).

A number of spiny-finned fishes of different families are often called perch, but the name is properly applied to some 90 species, most of them American, of the genus *Perca*. The perch family (*Percidae*) includes the walleyed pike (*Stizostedion vitreum*), also called pike perch and yellow pike. This valuable food and game fish is especially abundant in the Great Lakes and in adjoining lakes and rivers to the north. It may grow to be more than three feet long and to weigh as much as 18 pounds. Various so-called sea perch found off the Atlantic coast of North America belong to different families.

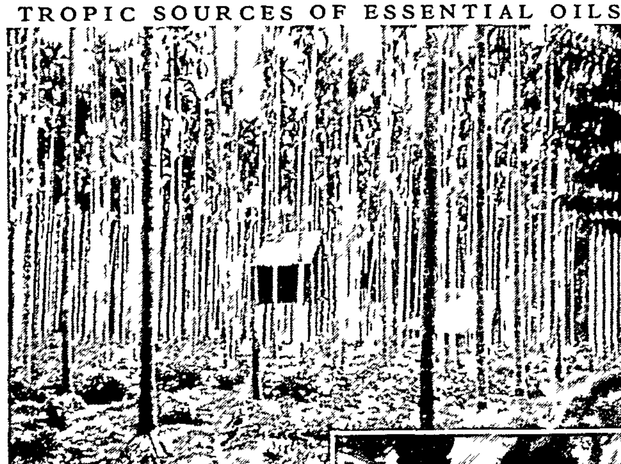
The STORY *and* SECRETS *of Our* PERFUMES

PERFUMES. From the remains of early civilizations in Asia Minor, Mesopotamia, and Egypt, we know that perfumes and cosmetics were used in very ancient times. Numerous citations in old Chinese and Indian literature reveal a wide vogue for them. Phoenician traders distributed them throughout the length and breadth of the Mediterranean. At the height of the Roman Empire, the use of perfumes reached extravagant proportions. Orange blossom water and extracts of aromatic plants were dispensed profusely during the elaborate banquets of that lavish period.

During the medieval era, the art of perfumery reached a new peak in Persia and Arabia, and the Crusaders returning from the Near East helped to acquaint Western Europe with the use of perfumes.

In the meantime, China and India had continued to develop perfumes from aromatic plants which did not grow in the Occident. When the great navigators of the 15th and 16th centuries established sea routes to the Orient, these exotic perfumes entered into European trade. The use of cosmetics, including perfumes, reached a new peak at the courts of Louis XIV and Louis XV of France. It was at about this time that the modern European perfume industry came into being in the Grasse region of southern France, a section exceptionally favored by temperate climate. Because of this development, Paris, as the seat of the royal courts, became the center for the manufacture of finished perfumes—a closely guarded art traditional within a few families and passed on from generation to generation. Paris remained the world center of the modern perfume industry for many years. But gradually the industry spread to new centers, particularly to the United States. The two World Wars hastened this movement, and American perfumers soon acquired access to all the raw materials necessary for fine perfumes.

TROPIC SOURCES OF ESSENTIAL OILS



Among bamboos of British Malaya (above), we see a plantation of the shrublike herbs known as patchouli, which belong to the mint family and yield fragrant oil. Below, in Ceylon, a native is shaving off slivers of cinnamon. Those from the inner bark will be crushed and their oil removed by steam distillation.

Ingredients of Fine Perfumes

WHAT MAKES a good perfume? It can be defined as a solution composed of approximately 10 to 15 per cent of scented oils and other aromatic products, and 85 to 90 per cent high-proof alcohol. The aromatic portion is a blend of the following items: (1) *essential oils,* (2) *extracted natural flower oils,* (3) *synthetic aromatics and aromatic isolates,* (4) *vegetable gums and resins,* and (5) *a few products of animal origin.*

1. Essential Oils

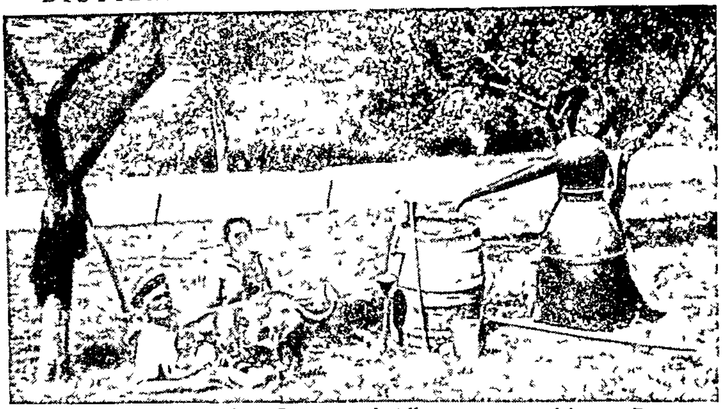
The indispensable ingredients of any perfume are the essential oils, also called volatile or ethereal oils. They originate in special sacs or cells of plants situated in the flowers, the leaves, the seeds, the bark, the roots, the wood, or in the covering of the fruit.

The commonest examples are the citrus oils. Squeeze the peel of an orange or lemon against a lighted match. The essential oil ejected by pressure will cause a slight explosion as it burns. At the same time you will notice a distinct fragrance. Hundreds of thousands of pounds of these citrus oils (lemon, orange, lime, bergamot, etc.) are produced annually by pressing the peels. This is done by hand in countries such as Sicily and French Guinea (West Africa), or by modern machinery in such larger citrus-fruit centers as California, Florida, and Brazil.

Mechanical pressure, however, is not an effective way to extract essential oils from the majority of the aromatic plants. Many require steam distillation. This is true of lavender, rosemary, eucalyptus, cloves, cinnamon, and a host of others. The plant material is loaded into large stills and steam is blown through the charge, thus rupturing the oil-bearing cells and vaporizing the oils. Steam and oil vapors pass into the condenser, where they become liquid again. Since essential oils and water do not mix, they form into two layers and the oil is easily collected.

There exist hundreds of different essential oils, some of them very common and produced in large quantities, some very expensive and produced on a much smaller scale. The best known include those already mentioned and the following: thyme, patchouli,

DISTILLING OIL OF LAVENDER IN FRANCE



This farm couple in southern France is distilling aromatic oil from a European mint, the lavender. Leaves, stems and flowers are boiled with water in the retort. The oil-laden vapor from its spout condenses in the barrel.

peppermint, spearmint, citronella, lemongrass, vetiver, geranium, wintergreen, sandalwood, ylangylang, and pine-needle. In most cases the plants yielding these oils are grown by natives as patch crops, and the oils are extracted on the spot in primitive stills and sent to the large manufacturers for further refining. In a few instances it is possible to dry the raw material sufficiently for shipment.

Generally, the percentage of the essential oil in a plant is very small. Four thousand pounds of rose petals are required to produce one pound of oil of rose (attar or otto of roses). One thousand pounds of the flowers of the bitter orange tree yield one pound of the so-called oil of neroli.

2. Natural Flower Oils

The more delicate flowers, for example, jasmine, tuberose, acacia, mimosa, violet, jonquil, hyacinth, and gardenia, do not lend themselves to steam distillation. Their aromatic ingredients must be isolated by other methods. One of the oldest is the process of *enfleurage*.

This process is based upon the fact that animal and vegetable fats readily absorb volatile aromatic substances. For this purpose, a highly purified fat is placed on both sides of glass plates which are supported one above the other in small airtight chambers. Freshly picked flowers are packed between these fat layers and allowed to remain there for a period of about 24 hours. The wilted flowers then are removed and replaced by a fresh batch, the fat always remaining on the glass plates. This process continues during the entire period of the flower harvest, which, in the case of jasmine, lasts about three months. At the end of the harvest, the fat has absorbed almost all the volatile substance emitted by the flowers and, therefore, is quite saturated with it. The fragrant fat (*pomade*) is removed from the glass plates with a spatula and the flower oil is extracted from it with alcohol.

The modern chemist has at his disposal more efficient methods. Today any flower material which cannot stand steam distillation is loaded into a large extractor, where it is treated for about half an hour with a solvent, such as petroleum ether (highly purified gasoline). Then the solvent is driven off from the mixture by distillation, leaving behind the natural flower oil, together with some extracted plant waxes. Upon further purification, the concentrated natural flower oil is obtained. These products, the so-called "absolutes," represent the most expensive ingredients used in the compounding of fine perfumes. The natural-flower oil of tuberoses, for example, has often commanded a price of $2,000 a pound.

3. Synthetic Aromatics

These products are prepared by chemical methods either from coal-tar products or from low-priced essential oils. Thus, through the chemist's ingenuity, it is possible to manufacture hundreds of synthetic ingredients of perfume, such as the artificial musks which possess an odor similar to that of natural musk, or benzyl acetate, the odor of which resembles that of jasmine flowers, or phenyl acetaldehyde which strikingly recalls the odor of hyacinth.

It is possible also to isolate from low-priced essential oils certain constituents which by chemical treatment can be converted into other substances. In this way, the chemist has succeeded in isolating from oil of lemongrass a constituent called "citral," which has a powerful lemon-like odor and is used in compounding synthetic lemon blends. This citral, in turn, can be converted into the so-called "ionones" which possess the characteristic odor of violets and are widely used in perfumes, cosmetics, and soaps.

SQUEEZING CITRUS OIL

A Sicilian squeezes citrus oil from lemon peels, their oil cells opened by soaking in water. The sponge absorbs oil and lets water through

Most of the synthetic aromatics and aromatic isolates possess strong and lasting odors and have become essential in the blending of modern perfumes.

4. Vegetable Gums and Resins

Certain plants, most of them good-sized trees, exude gums or resins that are among the oldest materials used in perfumery. These include myrrh, opoponax, olibanum (frankincense), benzoin, styrax, and labdanum. These possess very lasting odors, and are used extensively for the "fixing" of perfumes. In other words, they serve to prolong the life of some other odor included with them in a perfume. This holding

or fixing quality results from the low volatility of the gum or resins.

5. Products of Animal Origin

Of all the ingredients of a perfume, the animal products are the least important insofar as quantity is concerned, but they are indispensable in the creation of a perfect blend. Four products are used for this purpose—musk, civet, ambergris, and castoreum. All are prepared as alcoholic tinctures.

Musk is a reddish-brownish, grainy substance originating in a special gland of the musk deer of Central Asia (*see* Musk Deer). The content of this gland has an extremely powerful odor, disagreeable in concentrated form, but very effective when diluted and blended with other odors. Because of the difficulty of hunting the musk deer, which must be killed in order to extract the musk, and because the musk deer is becoming rare, the price of natural musk has risen greatly in recent years.

Civet originates from a special gland of the civet cat, an African animal especially common in Ethiopia. These cats are kept in cages, fed on raw meat, and are teased regularly into a state of fury in order to develop the secretion within the gland. The scooping out of this secretion with a spoon from the gland of the live animal is a cruel procedure. Civet consists of a brownish butterlike mass possessing a very strong and obnoxious odor. Yet when diluted and blended, it adds a pleasant penetrating quality to perfumes.

Ambergris is a secretion formed in the intestines of sperm whales around any hard object they have swallowed but cannot digest. It is sometimes found floating on tropical seas or washed up on beaches in masses as large as 200 pounds. It is a waxy substance, usually of grayish color, and is very expensive.

Castoreum comes from the glands of the beaver, which must be killed in order to obtain it. In dried form, castoreum is a dark matter possessing a very penetrating odor. It is the most widely used of the animal products.

Toilet Waters and Other Perfume Products

When a perfume is diluted with alcohol, and perhaps some water, until it contains from 3 to 5 per cent of aromatic ingredients, instead of 10 to 15 per cent, it is called a toilet water or a cologne. The original *eau de Cologne* was a specific preparation of blended citrus and flower oils, but the name "cologne" is now frequently applied in the trade to any of the more diluted types of toilet water.

Soaps, face powders, and other cosmetics are usually given their scents with the less expensive perfume ingredients. These commoner aromatics are also widely used in industry to give an agreeable odor to leather, paper, inks, lacquers, and shoe polishes, or to mask the disagreeable smell of chemical preparations, such as insect sprays and disinfectants.

PERICLES (about 493–429 B.C.). When we think of Athens, the greatest city of Greece, at the height of its glory, we think of Pericles, the statesman who made possible that golden age which bears his name, and who represents to the world the ideal Athenian.

PERICLES
Leader at Athens in the "Golden Age"

Pericles' power exceeded that of many kings and tyrants, yet he never held the office of *archon*, which was supposed to be the highest in the state. He was simply one of the ten "generals" (*strategi*) elected each year by the Athenians to manage their affairs at home and abroad, and he owed his power entirely to his personal ascendancy and his eloquence. He ruled Athens because the Athenians learned to trust him. For 30 years they reelected him, and he made their city glorious and never failed them in times of difficulty. When he appeared before the assembly, so serene and quiet was his manner that he might have been taken "for a god from Olympus."

More than anything else Pericles was interested in the good of the common people, although he himself was of the richest and most powerful family in all Athens. To begin with, he got the poor man enough to eat and an equal chance before the law, and then laid art and beauty open to him. The temples and statues of the Acropolis which he caused to be erected were more beautiful than the richest man's private house; and in order that the poor man might also enjoy music and drama, Pericles arranged for him to have a ticket and paid him so that he could afford to stop his work to attend the performance. Thus the people lived in an atmosphere of beauty and culture such as the wealthiest men could not have procured for themselves. His enemies charged him with spending the public money too freely, but he spent it all for the good of the people and the glory of Athens

Pericles came of the powerful family of the Alcmaeonidae, "the most brilliant, the most ambitious, and the most democratic of the noble families of Athens." The greatest events in Greek history took place in his lifetime. He was born not long before the battle of Marathon (490 B.C.), and as a boy probably witnessed the battle of Salamis in which the Greek fleet defeated the host of Persian invaders. When as a young man he entered public life, Athens still retained the scars of these terrible conflicts. Under his patronage were produced the wonderful sculptures of Phidias and the great dramas of Euripides and Sophocles.

Pericles realized his ambition to make Athens, "the queen of Hellas," not only the most beautiful but the most powerful of the Greek states. He lived also to see the states of the Peloponnesus, under Sparta's leadership, rise against Athen's overgrown power in the Peloponnesian War. The closing years of his life were times of storm and trouble. While Athens was besieged by the enemy outside the walls, a terrible plague raged within. For the first time Pericles fell from popular favor and was deposed from office. He was even fined 50 talents on a charge of embezzlement. Only a few weeks later the people repented and reinstated him with greater powers than before. But weakness from an attack of plague killed Pericles the following autumn.

The speeches of Pericles were not written down and preserved, but Thucydides in his history gives us some idea of Pericles' power as an orator. The funeral oration that he represents Pericles as speaking over the dead in the first year of the Peloponnesian War is especially noble: "Of all cities Athens alone is even greater than her fame. She needs no poet to sing her praises; every land and every sea can furnish proofs of her enterprise and success. Her enemies when defeated are not disgraced; her subjects confess that she is worthy to rule them." Of those who died in the defense of Athens, he says: "To men who fall as they have fallen death is no evil."

PERIODIC TABLE. The arrangement of chemical elements shown on the next page started with Dmitri Mendeléev, a Russian chemist. In 1869 he arranged all the known chemical elements in the order of increasing atomic weights. He found that, for the first twenty, each one resembled the eighth element following it in appearance, properties, and activity. Thus lithium, sodium, and potassium are related, as are beryllium, magnesium, and calcium. In the table, these series appear in Groups IA and IIA.

Mendeléev's table had many gaps, and the order by atomic weight introduced several contradictions in the sequence of chemical properties for some elements—cobalt and nickel, for example. But discoveries of other elements filled the gaps; and the use of atomic numbers removed the contradictions.

Atomic Numbers Fix the Order of Elements

The articles Atoms and Chemistry show that the different kinds of atoms are built up in a perfectly regular way. The lightest atom (hydrogen) has a nucleus with one positive electrical charge and one electron to match. Adding one positive charge (and two neutrons) to the nucleus of hydrogen and adding one electron make an atom of helium. Other additions of protons and electrons in equal numbers (plus neutrons) build up the other kinds of atoms. Since neutrons do not affect chemical activity, the number of positive charges (or the number of electrons) identifies the kind of atom. This important number is called the *atomic number*.

Atomic numbers also characterize elements. An element is defined as a substance made of atoms that have the same atomic number. Furthermore, the elements are arranged in modern Periodic Tables according to atomic numbers rather than atomic weight.

Unfilled Electron Shells Determine Families

The *atomic number* gives the order, or sequence, in which elements are to be listed in the table; but the *number of electrons* in the unfilled shells of the atoms indicates the families, or groups, in which the elements appear in the table. This family grouping occurs because the electrons in unfilled shells have pronounced influence upon the physical and chemical properties of atoms. The term "shell" is used because the electrons in atoms are arranged in energy levels, or shells, around the nuclei.

Elements having all electrons filled in (satisfied shells) are called *noble gases* (Group VIII (0) of the accompanying table). They begin with helium, which has two electrons. The others, beginning with neon, have eight electrons in the outer shell.

Since chemical activity arises from electrons in an *incomplete* outer shell, atoms having the same number of electrons in this shell have similar chemical properties. This can be shown for the outer shells of several light elements, using dots for electrons:

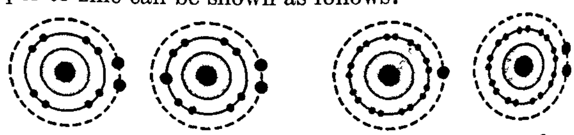
H•							•He•
Li•	•Be•	•B•	•C•	•N•	•O•	•F:	:Ne:
IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII(0)

Period 1 contains only hydrogen and helium, because helium has a filled, or "satisfied," outside shell. Period 2 starts with lithium, which has one electron outside the completed helium shell, and ends with the next "satisfied" configuration in neon, with eight electrons. The arrangement shows chemical relations. Hydrogen acts like lithium, while helium and neon are both chemically inert.

Atoms of the elements in Period 3 resemble those above them in outer shells and also chemically. Potassium and calcium in Period 4 likewise resemble lithium and beryllium, respectively (*see* Chemistry); but after calcium, there is a change.

Transition Elements Have Unfilled Inner Shells

The electron which adds to those of calcium to make the element scandium goes into an inner shell rather than into the outermost shell. Additional electrons go to this reopened inner shell until 18 are present in an atom of copper. The array of elements so formed is called the *first series of transition elements*. In the copper atom the addition of an electron to the inner shell (the 17th) also draws one electron (the 18th) from the pair previously in the outer shell. The outer electron pair is restored in the next element, zinc. The changes from calcium to scandium and from copper to zinc can be shown as follows:



CALCIUM SCANDIUM COPPER ZINC

After zinc, the outer shell resumes filling to eight electrons in the inert gas krypton. Other transition

A PERIODIC TABLE OF THE ELEMENTS

PERIOD / GROUP	I A	II A	III A	IV A	V A	VI A	VII A	VIII			I B	II B	III B	IV B	V B	VI B	VII B	VIII (O)
1	1 H Hydrogen																	2 He Helium
2	3 Li Lithium	4 Be Beryllium	*Elements above and to the right of this line are nonmetals.*										5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
3	11 Na Sodium	12 Mg Magnesium	*Elements below and to the left of this line are metals.* TRANSITION ELEMENTS										13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 A Argon
4	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
5	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
6	55 Cs Cesium	56 Ba Barium	57-71 Lanthanides (see below)	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
7	87 Fr Francium	88 Ra Radium	89-103 Actinides (see below)															

INNER TRANSITION ELEMENTS

Lanthanide Series	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
Actinide Series	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99	100			

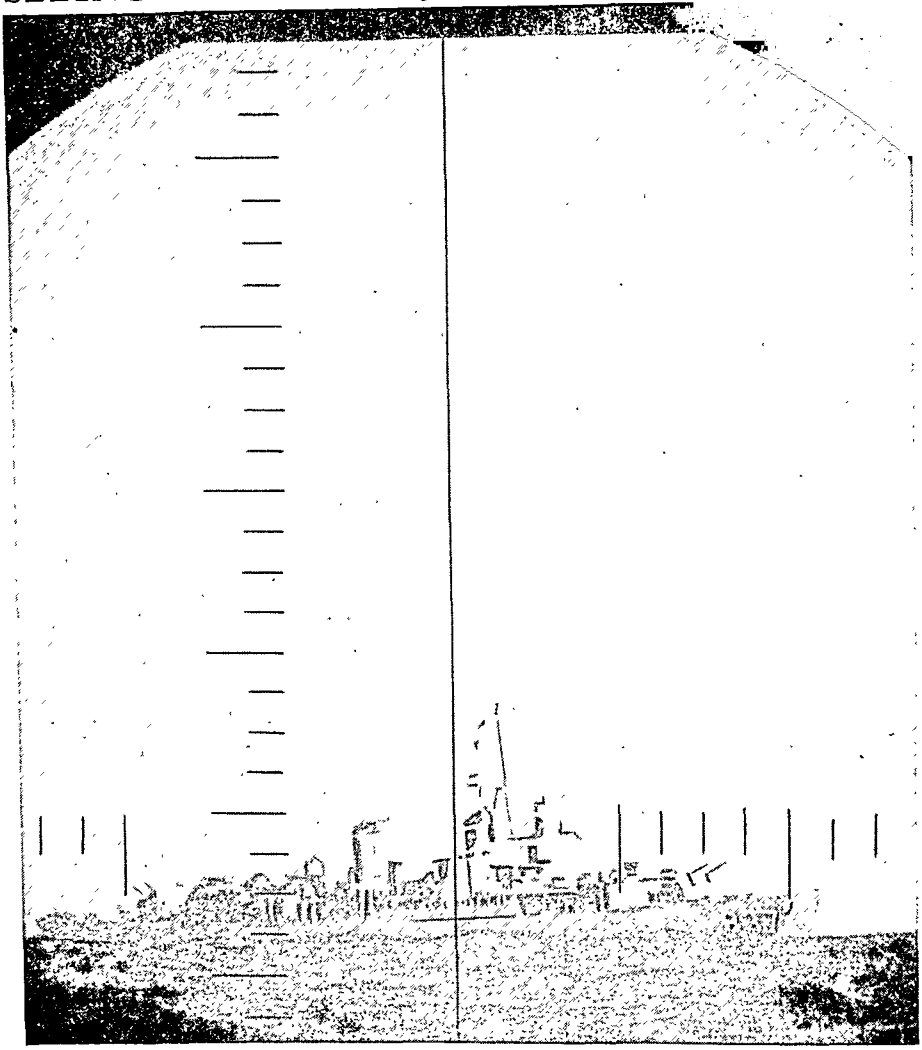
Here the chemical elements are arranged in periodic order by atomic number. (Atomic numbers are in the upper left corners of each square.)

Periods 1 to 3 have a gap on the left side to allow for the insertion of the *transition elements* in later periods. Two "transition series within a series" (the lanthanides—atomic numbers 57 to 71—and the actinides—atomic numbers 89 to 103) are shown below the main table to keep the remainder of the series in which they occur in as simple an order as possible.

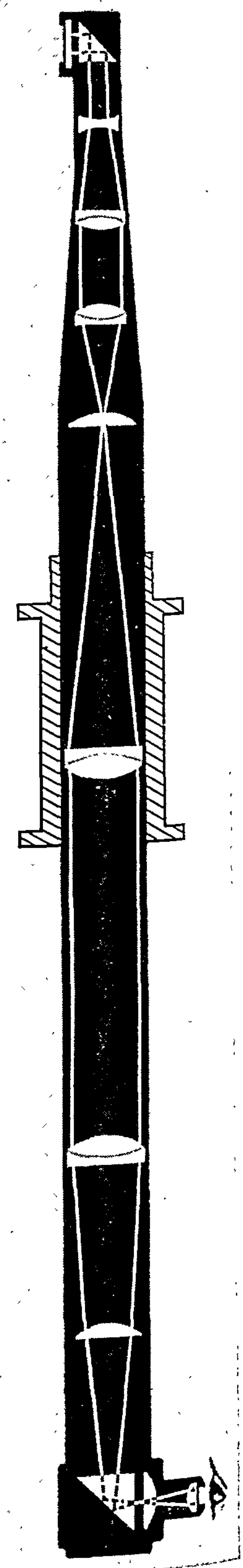
Group numbers across the top of the table (I A, II A, I B, II B, etc.) give clues to the elements' chemical properties, such as metallic or nonmetallic, etc. The "A" sequence is used because changes in chemical properties from left to right continue from Groups I A and II A through most of the transition elements. But the last two groups (copper, silver, gold; zinc, cadmium, and mercury) of the inserted series repeat somewhat the chemical properties of Groups I A and II A, as well as the properties of the transition elements. They are called Groups I B and II B.

From Group III B onward, chemical properties repeat somewhat those from III A onward but they are not transition elements.

SEEING SURFACE OBJECTS WITH A SUBMARINE PERISCOPE



This destroyer was photographed through a submarine periscope. The set of horizontal and vertical lines (called a telemeter) enables the submarine observer to gauge distances of objects.



Here a submarine officer scans the horizon through his periscope. He turns (trains, or "walks") the instrument through 360 degrees to get a complete view. At the right is a greatly simplified diagram of the arrangement of lenses and prisms in a periscope. The white lines show how the image reaches the eye. The actual details are closely guarded naval secrets.

series occur at the same point throughout the rest of the Periodic Table. In fact, Periods 6 and 7 each has a "series within a series." This happens because *two* inner shells build up while the outermost shell remains unchanged. In Period 6 one inner shell builds from 18 to 32 to make the lanthanide series; then the second inner shell builds from hafnium through mercury before the outermost shell fills from thallium to radon. The actinides enter Period 7 similarly.

Metals Have Low Electron Attracting Power

In the Periodic Table the nonmetals (except hydrogen) are found on the upper right side, whereas the metals are in the center and on the left side. This separation of metals from nonmetals arises from the factors that affect the relative electron-attracting power of atoms. Those elements whose atoms have a low electron-attracting power are metals; they lose electrons readily and become positive ions in solutions and crystals. Those elements whose atoms have a high electron-attracting power are nonmetals; they gain more electrons to form negative ions.

The electron-attracting power of atoms depends upon (1) the size of the atom, (2) the amount of charge on the nucleus, and (3) the number of intervening shells of electrons. The larger the diameter, the weaker is the attracting power of the nucleus for outside electrons. The power of attraction for outer electrons decreases as the number of intervening electron shells increases. These two factors working together are most effective in the atoms of elements on the left side and center of the table. Hence these elements are metals.

The greater the charge on the nucleus the greater the electron-attracting power of atoms. This factor is very effective for atoms of elements on the right side of the table, probably because the charge builds up as we go across the table and no new shells are developed to repel the charges. Thus the elements on the right of the table are nonmetals.

PERISCOPE. With the periscope to indicate what is going on above the surface of water, a submarine can glide virtually unseen below the surface. This ability to see enemy ships while remaining unseen by them makes submarine warfare effective.

On a submarine, a periscope is a rustless steel or bronze tube, usually about 44 feet long and 6 inches in diameter, tapering to about 2 inches. The top is narrowed and streamlined to reduce the track, or wake, which betrays the presence of a submarine cruising below the surface.

At the top and bottom of the periscope reflecting prisms bring the scene before the top prism to an observer in the submarine, as shown in the diagram on the opposite page. The upper telescope reduces the image, because the observer is looking through the large end of a telescope; but the lower telescope enlarges the image again, sometimes to six times the size of the original picture.

A "telemeter" scale, consisting of short lines set slightly off vertical and horizontal centers of the field of vision, enables an observer to estimate the size and approximate distance away of any object in his field of vision. The observer's eyepiece usually is cemented to the lower prism between two handles by which the periscope is turned. The field periscope, a smaller instrument, is used in trench warfare to see over the parapet. (*See also* Lens; Submarine; Telescope.)

PERRY, OLIVER HAZARD (1785–1819). "To windward or to leeward, they shall fight today." This was the grim determination which the venturesome young commander, Oliver Hazard Perry, announced on Sept. 10, 1813, when some of his officers begged him to refrain from battle with the British that day on account of the wind's direction. With this decision he engaged in the bloody battle of Lake Erie, upon the issue of which rests his fame as one of the great naval heroes of the United States.

Several motives inspired Perry's determination. For one thing he had the family honor to sustain. His father had served with credit as a naval officer in the Revolutionary War, his three older brothers were then serving in the Navy in the War of 1812, and his youngest brother was with him on board the *Lawrence* at the time of battle. He himself had entered the Navy as a midshipman from his Rhode Island home in 1799, had served in the war against the Barbary pirates, and at his own request had been sent to serve on Lake Erie in the war.

Here at Presque Isle, near Erie, Pa., in the midst of a wilderness, he had undertaken with enthusiasm the arduous task of building and equipping a fleet, although men and materials had to be brought through trackless forests from the seaboard, 500 miles away. The work had been successfully completed and Perry had under his command nine small vessels which he was anxious to use. The fact that his commanding officer, Commodore Chauncey, had not given him the support and encouragement he needed was an additional reason for showing that he could win in spite of all difficulties.

The results of Perry's decision justified his expectations. His own vessel, the *Lawrence*, was so disabled that he had to leave it and row to the *Niagara* in a hail of bullets, but within two hours after leaving his ship he sent his famous message: "We have met the enemy and they are ours—two ships, two brigs, one schooner, and one sloop." For the first time in its long naval history, a British fleet had been compelled to surrender.

For this victory Perry was rewarded with the rank of captain and a vote of thanks by Congress. He was regarded by the people of the country as the naval hero of the war and was popularly known as "Commodore" Perry. After peace was declared he was placed in command of a squadron in the West Indies and there met his death a few years later from the dreaded yellow fever. The Perry Memorial shaft on Put-in-Bay, South Bass Island, Ohio, was dedicated in 1913. In 1936 the site became a national monument (*see* National Parks and National Monuments).

PERSEUS. In Greek mythology, Perseus was the strong and handsome young hero who slew the dread Gorgon, Medusa. Perseus was the son of Zeus, king of the gods, and Danaë, beautiful daughter of Acrisius, the old and evil king of Argos. Acrisius had banished mother and son because an oracle had said Danaë's son would one day kill him. Polydectes was king of the island where Danaë and Perseus had been carried under Zeus's guidance. He wooed Danaë, but knew that he would have to get rid of Perseus before he could win Danaë's hand. So he sent the youth to bring back the head of Medusa, thinking Perseus would be killed.

Medusa was one of three terrible sisters, called Gorgons. They had leathery wings, brazen claws, and writhing poisonous snakes instead of hair. Anyone who looked at them turned to stone. But Perseus was helped by the gods. Athena lent him her brightly polished shield. Hermes gave him a magic sword and a pair of winged sandals; Pluto gave him the cap of darkness which made him invisible. After traveling a long time, Perseus came to the land of eternal night, where the three Gray Sisters (the Graeae) lived. They had only one eye and one tooth among them. They refused to help Perseus, but he stole their eye and returned it only when they told him where to find the Gorgons.

He set out again and finally found the three Gorgons asleep. He put on his cap of darkness and flew nearer. Alighting, he looked into his shining shield, thus avoiding a direct look at the Gorgons. With one stroke of his sword he cut off Medusa's head. Before the other two Gorgons awakened, his magic sandals carried him to safety.

With his magic sword, Perseus later slew a sea monster and rescued its intended victim, the beautiful maiden, Andromeda. Her rejoicing parents, Cepheus and Cassiopeia, gave Andromeda to Perseus as his bride. At the wedding, an old suitor claimed Andromeda; and Perseus turned him into stone by holding the head of Medusa before him.

Perseus accidentally killed his grandfather Acrisius in a game, and thus fulfilled the old prophecy. After his own death, Perseus was taken into the sky by his father Zeus, as were also Andromeda, Cassiopeia, and Cepheus. There they became constellations, all according to the old Greek myths.

PERSHING, GEN. JOHN JOSEPH (1860–1948). At 57 "Black Jack" Pershing became the commander of the forces that turned the tide in the first World War. For his leadership, he was promoted to the permanent rank of general, a grade held up to that time only by Washington, Grant, Sherman, and Sheridan.

Pershing was born near Laclede, in Linn County, Mo., on Sept. 13, 1860. He was a descendant of Frederick Pershing (originally Friederick Pfoershing), of Alsace, who came to America in 1749. John as a boy was not a brilliant student but he was determined to get an education. When he was about 17 he began to teach in a country school. Later, with the money he had saved, he entered the normal school at Kirksville, Mo. While there he saw a notice of a competitive examination for West Point. He did not then think of a military career; but he wanted a good education, and West Point offered an unusual opportunity. He won the appointment by a single examination point.

GEN. JOHN J. PERSHING

He led the American Expeditionary Force in the first World War.

Graduating from West Point in 1886, he began active service against the rebel Indians in the West. Five years later he was appointed military instructor at the University of Nebraska, where he also studied law. He completed the course and received a bachelor of laws degree. He served at West Point as an instructor in tactics until the Spanish War in 1898. He asked for active service and was among the first 15,000 who sailed for Cuba. Two days later he was fighting in the battle of San Juan Hill.

On his return Pershing requested to be sent to the Philippine Islands, which the United States had just acquired. His work was to put down the islands' savage tribes. The largest of these was the Moros, a people the Spaniards had never been able to conquer. In 1903 he was recalled and made a member of the General Staff Corps in the United States. In 1905, when the Russo-Japanese War broke out, he was appointed military observer with the Japanese army.

At 45 he was still a captain. His advancement was too slow, President Theodore Roosevelt thought, for an officer of his ability. The president promoted Pershing over the heads of 862 officers of higher rank and made him a brigadier general.

In 1909 Pershing returned to the Philippines as governor of the Moro Province. He was recalled in 1914 to pursue the Mexican bandit Villa. Then he experienced the greatest tragedy of his life. His wife and three little daughters were burned to death in a fire in San Francisco. His son alone was saved.

In the meantime war was raging in Europe, and finally the United States was drawn in. Secretary of War Baker and President Wilson selected General Pershing to command the American forces. Given a free hand, Pershing had the heavy task of shaping and training a whole army organization which finally expanded in a year and a half to nearly 2,000,000 men. His final test as a commander of men in the field came only in the last few months, but he carried out his mission with great success.

In 1919 he was appointed "General of the Armies of the United States," a title no other officer has held. In 1924 he was retired from active duty. After several years' illness, Pershing died July 15, 1948, at 87. He was buried in Arlington National Cemetery.

PERSIAN GULF. The Persian Gulf thrusts northwest from the Arabian Sea, separating the Arabian peninsula from Iran (Persia). The gulf is 520 miles long and from 150 to 200 miles wide—about three times the size of Lake Superior. Its average depth is about 200 feet. The Strait of Ormuz, 30 to 60 miles wide, connects it with the Gulf of Oman, which opens into the Arabian Sea, a part of the Indian Ocean.

The Arabs called the Persian Gulf the Green Sea because of the color given it by great quantities of microscopic marine life. The coast is flat and sandy on the Arabian side, high and steep on the Iranian side. Into the head of the gulf flow the waters of the Tigris and Euphrates rivers after uniting to form the estuary called Shatt-el-Arab.

The largest island group is Bahrein, a British protected state. These islands are famous today, as in early times, for their pearl fisheries; but even greater wealth is now obtained from oil, discovered in 1932. The British became the dominant power in the Persian Gulf area by the end of the 18th century. They prevented encroachments by Russia, which has long coveted a port on this warm sea.

ANCIENT PERSIA—*Head of a* VAST EMPIRE

PERSIAN HISTORY. Egypt, Babylon, and Assyria were many centuries old when a vigorous people appeared on the eastern border of the Semitic world. They came from the grasslands of Turkestan with their sheep and horses, and made their homes on the high mountain-walled plateau between the Caspian Sea and the Persian Gulf.

The newcomers called themselves Irani (Aryans), and their new homeland Irania (modern Iran). But they became known as Persians, because Greek geographers mistakenly named them after the province Parsa, or Persis, where their early kings had their capital. The Persians and their close relatives, the Medes, were white people, like the Semites. But they spoke a different language. We call this language Indo-European because other Aryan tribes spread it into India as well as over Europe.

The Medes and Persians had many nature gods. In the 6th century B.C. a great religious prophet appeared in Media. His name was Zoroaster, or Zarathustra. He taught that there was only one supreme god, Ahura Mazda, the spirit of light and of good. There was constant conflict between Mazda and the spirit of darkness, or evil, Ahriman. Zoroaster taught that it was man's duty to help Ahura Mazda by living morally (*see* Zoroaster).

HOW THE "PARTHIAN SHOT" GOT ITS NAME

In war the Parthian horsemen poured a shower of darts on the enemy, then wheeled and pretended to take flight. But as they fled they shot more arrows backward on the foe. The phrase "Parthian shot" is still used for a parting shot, or remark.

Cyrus Founds the Persian Empire

At this time the Medes had their own kingdom in western Iran. They ruled the Persians to the east and the Assyrians to the west. But in 550 B.C. King Cyrus of Persia conquered the Medes, then pushed on to further conquests. His warriors, both Medes and Persians, were excellent horsemen, skillful with bow and arrow. They relied upon speed and sharp attack. They carried light hide-covered shields. Before the heavily armored enemy troops could come close, the Persian cavalry overwhelmed them with a storm of arrows.

Cyrus won Assyria when he defeated the Medes. His next conquest (546 B.C.) was the kingdom of Lydia, ruled by the fabulously wealthy King Croesus (*see* Croesus). This victory gave him possession of the Greek seaboard cities of Asia Minor. In 539 B.C. the proud city of Babylon, capital of the Chaldean Empire, surrendered without a fight. With Babylon Cyrus acquired Palestine. He allowed the Jews to return there and rebuild their temple in Jerusalem (*see* Jews). Later he turned east and spread his empire to the border of India. He was killed fighting against eastern nomads in 529 B.C. and buried in a tomb he had prepared at his capital, Pasargadae. (The ruins still remain.)

Cyrus was a great statesman as well as a warrior and treated his conquered enemies with mercy. Cyrus' son Cambyses, who ruled from 530 to 522 B.C., was a cruel tyrant. He conquered Egypt in a short campaign.

Darius Organizes the Empire

Darius, a cousin of Cambyses, seized the crown in 522 B.C. Under this "Great King, King of Kings," the empire reached its height of wealth and glory.

Darius' greatest work was perfecting the system of government begun by Cyrus. The empire was divided into 20 *satrapies* (provinces), each ruled over by a

satrap. An official called the King's Eye made regular visits to the satrapies and reported to the king. The satrapies furnished soldiers for the king's armies. Phoenicia, Egypt, and the Greek colonies of Asia Minor also supplied ships and sailors. Each satrap paid a fixed yearly tribute to the Great King.

Enormous wealth flowed into the royal treasure houses of Susa, Persepolis, Pasargadae, and Ecbatana. When the king required money, he minted gold coins. To encourage commerce, Darius standardized coins, weights, and measures, built imperial highways, and completed a canal from the Nile to the Red Sea. He demanded strict enforcement of the severe "laws of the Medes and Persians, which altereth not."

Throughout his reign Darius was forced to suppress revolts in the empire. In 500 B.C. the Greek cities of Asia Minor rebelled. After putting down this rebellion, Darius turned on Athens to punish it for sending aid to the rebels. Beaten in the famous battle of Marathon, he prepared another expedition, but died (486 B.C.) before it started (*see also* Marathon).

Decay of the Persian Empire

Xerxes, Darius' son (ruled 486–465 B.C.), was weak and tyrannical. He began his reign by quelling rebellions in Egypt and Babylon, then gathered a huge force to overwhelm Greece. It seemed as if the mighty empire must conquer the small, disunited Greek cities. Yet Xerxes met disaster at Salamis and Plataea, and his great army was driven back into Asia (*see* Salamis). The story of Persia's war with the Greeks is told in a separate article (*see* Persian Wars).

This defeat marked the first sign of decay in the mighty Persian Empire. Persian history for the next 125 years was filled with conspiracies, assassinations, and the revolts of subject peoples ground down by ruinous taxation. The empire was briefly united under the bloodthirsty Artaxerxes III (Ochus), who ruled 362–338 B.C. He killed all his relatives and was then poisoned by his own physician. Arses, who succeeded him, was poisoned two years later, and all his children slain.

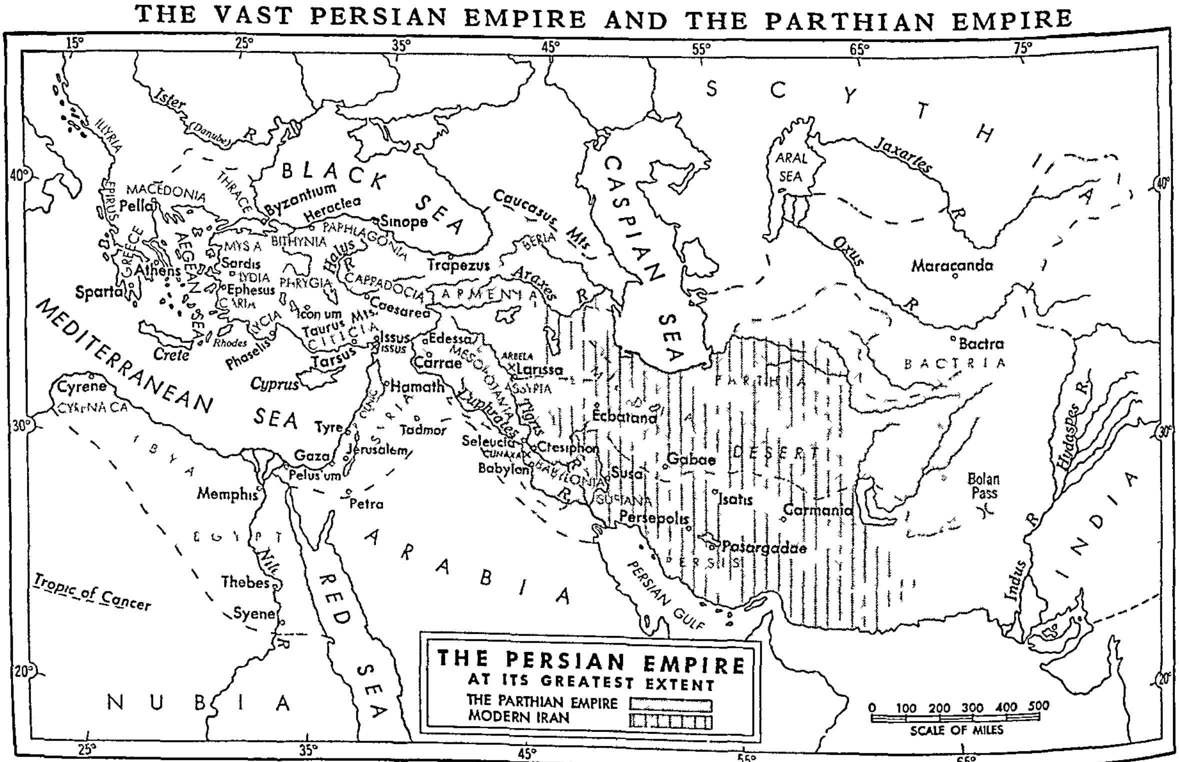
Darius III, a weakling, was on the throne when Alexander the Great of Macedon led his powerful army into Asia. In the decisive battle of Issus (333 B.C.) Alexander captured the western half of the Persian empire. Darius fled from the battlefield. He met Alexander again at Arbela (331 B.C.) and fled once more. Soon afterward one of his own followers murdered him. Thus the ancient line of Persian kings—the Achaemenid Dynasty—came to an end, and with it the Persian Empire. Alexander marched on to Persepolis, burned its magnificent palaces, and confiscated its huge treasure. (*See* Alexander the Great.)

The Parthian Empire

After Alexander's death (323 B.C.) one of his generals, Seleucus, seized Babylon and founded the Seleucid Dynasty. Parthia, a small kingdom in northern Persia, broke away, brought Persia under its rule, and built an empire that extended from the Indus River to the Caspian Sea.

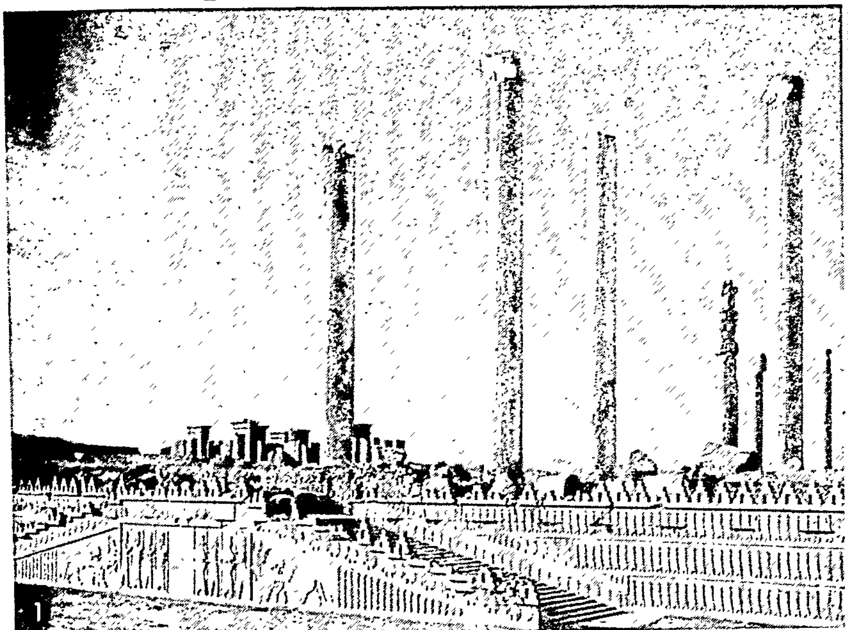
The Parthians were nomads, noted for their splendid horses. In battle they adopted the ruse of pre-

THE VAST PERSIAN EMPIRE AND THE PARTHIAN EMPIRE



At its height, (about 500 B.C.) the Persian Empire stretched from the Aegean Sea to the Indus River and included Egypt. The Parthian Empire flourished in Roman times. The stripes indicate the area of modern Iran.

EXAMPLES OF PERSIAN ART THROUGH THE AGES



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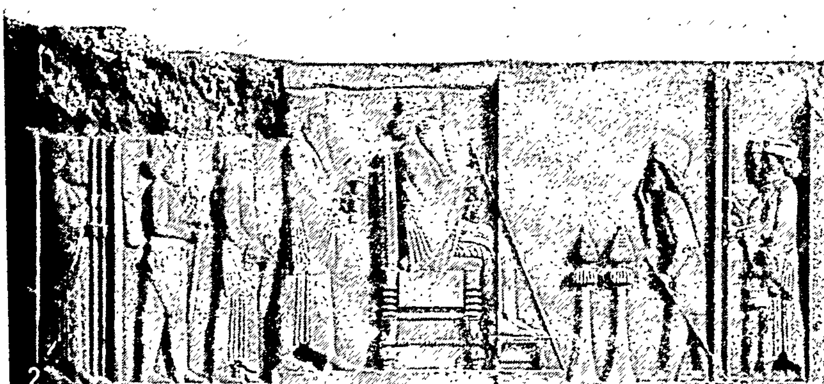

1. This great ceremonial stairway led to the royal audience hall of Darius and Xerxes at Persepolis. 2. A relief from a portico of the treasury in Persepolis shows Darius on his throne and his son Xerxes behind him. The king and prince wear longer beards than their attendants. 3. Persian potters had developed their art to a high point in the 13th century, when they produced this overglaze bowl. 4. Artists of the late 15th century executed the delicate miniature painting on this beautifully illuminated manuscript.

tending to take flight, then wheeling and firing a hail of arrows on their pursuers—hence the phrase, "Parthian shot." For 300 years they held off the power of Rome.

Persia under the Sassanids

In A.D. 226 the Persians again came under a native dynasty, the Sassanids. For four centuries the Sassanids warred with Rome, with the later Byzantine Empire, and with Huns and Turks. Most of their wars ended disastrously. Outside of Persia, they held firmly only Babylon, in the lower Tigris-Euphrates Valley.

The Sassanids upheld the orthodox Zoroastrian religion, punishing by death those who left the faith. Throughout Persia the magi, or priests, continued to guard the holy fires of Ahura Mazda. In the 3d century, however, vigorous new religions evolved from Zoroastrianism. Mithraism revived Persia's pagan sun god, Mithras—who had been banned by Zoroaster. Manichaeism (named for its founder Mani, the "ambassador of light") sought to reconcile Zoroastrianism with Christianity in a new world religion. Both Mithraism and Manichaeism spread from Persia into the Roman Empire, where they came into conflict with Christianity.

Persia Falls under Arab Rule

Until the 7th century Persia had rarely been under foreign domination. But it declined when the new faith of Islam arose. Islam inspired the Arabs to leave the deserts of Arabia and embark on world conquest (*see* Mohammed). After resisting desperately for a few years, Persia suffered two crushing defeats (636 and 641) and fell to the Arabs.

Mohammedan rule persisted for seven centuries. It gave the Persians a wholly new religion and altered their way of living. Yet Persian culture did not die. The Mohammedan rulers—the Abbasid caliphs—chose Baghdad (then in Persian territory) as their seat of government, and their court took on a Persian character. The tales of the 'Arabian Nights' unfolded in the Persian region (*see* Arabian Nights). Firdausi (940?-1020), Persia's greatest poet, sang in epic verse of Persia's early kings, and inspired miniaturists to

THE BEHISTUN ROCK, A LANGUAGE KEY

On this precipitous cliff in western Iran still stands a record of the triumphs of Darius the Great It was carved in cuneiform (wedge-shaped) characters, in the Persian, Babylonian, and Elamitic languages The picture shows how, more than 23 centuries later, workers scaled the height and made wet-paper impressions or "squeezes" Sir Henry Rawlinson deciphered the inscription, thus providing a key to the Babylonian and Assyrian languages.

make richly illuminated copies of his legends. Omar Khayyam (died about 1123), best known to the Western world as the author of the 'Rubaiyat', made important contributions to astronomy and mathematics

Persia's Golden Age

The Seljuk Turks conquered Persia in the 11th century. In the 13th century Genghis Khan's Mongols devastated the country, and near the end of the 14th century Timur Leng's horde swept over it. At last in 1502 Persian nationalism revived under the Safavid Dynasty. The Safavids claimed descent from Mohammed's family through his son-in-law Ali. They split Persia from the orthodox Mohammedans (the *Sunni*) by making *Shiism* the state religion.

Under Shah Abbas (1587–1629), the greatest of the Safavid Dynasty, Persia reached a golden age Art flourished during his reign—miniature painting, carpets, tapestries, metal work, and architecture Isfahan, the new capital, was embellished with gardens and a great palace, "The Hall of Forty Columns," faced with glazed tile in soft hues.

The Safavids held off the powerful Ottoman Turks, who had taken over the rule of Islam from the Arabs But Isfahan fell in 1722 to Afghan tribesmen, ending the Safavid Dynasty. Russia and Turkey then dismembered Persia. Its prestige was briefly restored by Nadir Shah (ruled 1736–47), a soldier-adventurer who became king. He freed Persia from Afghans, Turks, and Russians, and then invaded India.

Under the Kajar Dynasty (1794–1925), Russia gained control over northern Persia, and Great Britain became dominant in the south. Not until the 20th century did the Persian nation once more revive. As a symbol of the rebirth of national feeling, the government changed the ancient name of Persia to the still more ancient name Iran. (For later history, *see* Iran)

HOW EUROPE *Was Saved from* ASIATIC DOMINATION

PERSIAN WARS. In the 5th century B.C. the vast Persian Empire, then at the height of its power, determined to carry its conquests into Greece. If it had succeeded, Asiatic despotism would have crushed the first stirrings of democracy in Europe. The fate of Western civilization lay in the hands of the small, disunited Greek city-states. Against them was pitted Persia's overwhelming strength. The bitter struggle is known in Western history as the Persian Wars. The conflict lasted 20 years (499–479 B.C).

Persia already numbered among its conquests the Greek cities of Ionia, in Asia Minor, where Greek civilization first flourished. Some of these cities revolted against Darius I, the Great King, in 499 B.C. Athens sent 20 ships to their aid. Before the Persians crushed the revolt, the rebels burned Sardis, capital of Lydia. Darius, maddened with rage, asked, "Who are these Athenians?" When told, he appointed a slave to exhort him each day, "Master, remember the Athenians!"

In 492 B C. Darius sent a great military force and 600 ships across the Hellespont. A sudden storm wrecked half his fleet when it was rounding rocky Mount Athos on the Macedonian coast. Two years later Darius dispatched a new battle fleet of 600 triremes This time his powerful galleys plunged straight across the Aegean Sea and arrived safe off Attica

The Battle of Marathon

The Persians landed on the plain of Marathon, about 25 miles from Athens. When the Athenians learned of their arrival, they sent a swift runner, Pheidippides, to ask Sparta for aid, but the Spartans said they could not march until the moon was full Meanwhile the small Athenian army had encamped in the foothills on the edge of the Marathon plain.

The Athenian general, Miltiades, ordered his small force to advance. He had drawn up his men so as to have the greatest strength in the wings. As he expected, his center was driven back. The two wings then united behind the enemy. Thus hemmed in, the Persians' bows and arrows were of little use. The stout Greek spears spread death and terror. The invaders rushed in panic to their ships. The Greek historian Herodotus says the Persians lost 6,400 men

against only 192 on the Greek side. Thus ended the epochal battle of Marathon (490 B.C.), one of the decisive battles of the world (*see* Marathon).

Darius planned another expedition, which he intended to lead in person, but he died before his preparations were completed. This gave the Greeks a ten-year breathing period. Athens used the time to build up its naval supremacy in the Aegean, under the guidance of Themistocles.

The Battle of Thermopylae

In 480 B.C. the Persians returned, led by King Xerxes, the son of Darius. To avoid another shipwreck off Mount Athos, Xerxes had a canal dug behind the promontory. Across the Hellespont he had the Phoenicians and Egyptians place two bridges of ships, held together by cables of flax and papyrus. A storm destroyed the bridges. Xerxes had those in charge beheaded and began again. For seven days and nights his soldiers crossed the bridges under the lash.

On the way to Athens, Xerxes found a small force of Greek soldiers holding the narrow pass of Thermopylae, which guarded the way to central Greece. The force was led by Leonidas, king of Sparta. Xerxes sent a message summoning the Greeks to deliver up their arms. "Come and take them," replied Leonidas.

For two days the Greeks' long spears held the pass. Then a traitorous Greek told Xerxes of a roundabout path over the mountains. When Leonidas saw the enemy approaching from the rear, he dismissed his men except the 300 Spartans, who were bound, like himself, to conquer or die. Leonidas was one of the first to fall. Around their leader's body the gallant Spartans fought first with their swords, then with their hands and teeth, until they were slain to the last man. (*See also* Thermopylae.) Later, Greeks erected a monument at the pass inscribed with these words:

> Go tell the Spartans, thou that passest by,
> That here obedient to their laws we lie.

The Naval Battle of Salamis

The Persians moved on to Attica and found it deserted. They set fire to Athens with flaming arrows. Xerxes sat on a marble throne upon a height overlooking the sea. His grand fleet held the Athenian ships bottled up between the coast of Attica and the island of Salamis. His ships outnumbered the Greek ships three to one. He had expected an easy victory, but again and again he started up in rage, as one after another of the Persian vessels was sunk or crippled by the onslaught of the courageous Greeks.

The Persian vessels were heavy. Crowded into the narrow strait, they moved with difficulty. The lighter Greek ships rowed out from a circular formation and rammed their prows into the clumsy enemy vessels. Two hundred Persian ships were sunk, others were captured, and the rest fled (*see* Salamis).

Xerxes hastened back to Persia. Soon after, the rest of the Persian army was scattered at Plataea (479 B.C.). In the same year Xerxes' fleet suffered another defeat at Mycale. Europe was saved from Asiatic conquest. (*See also* Greece; Persian History.)

PERSIMMON. When ripe, the delicious fruit of the persimmon tree has a spicy-sweet flavor. However, Capt. John Smith, one of the first white men to taste the persimmon, aptly recorded his reaction to the immature fruit: "If it be not ripe, it will draw a man's mouth awrie with much torment."

The "pucker" is caused by the presence of tannin in the immature persimmon. The tannin's effect virtually disappears by the time the fruit is ripe. On some trees the fruit matures and ripens about frost time; and many people mistakenly think that frost is necessary for ripening. Actually the maturation season ranges from August to January.

The persimmon tree is found as far north as Connecticut, but grows best in the cotton climate of the South. Commercial orchards have been established in southern California and in areas that border the Gulf of Mexico. Individual trees or small groups grow in many southern yards and gardens. The native persimmon (*Diospyros virginiana*) has a rich-flavored fruit, but it does not ship well. Most of the orchards grow the Japanese persimmon (*Diospyros kaki*), which has a larger fruit. Seeds for the first Japanese persimmon tree in the United States were sent back by Commodore Matthew C. Perry in 1856. The tree reaches a maximum height of 100 to 130 feet.

The persimmon tree is a relative of the ebony, and its dark, heavy wood has many of the same characteristics. It is one of the hardest of all woods and takes a high, glossy polish. Persimmon wood is used for golf-club heads, textile-loom shuttles, and parquet floors.

American Indians dried the fruit or combined persimmon pulp with corn to make a kind of bread. Today most persimmons are eaten fresh, often with sugar and cream. They may also be made into puddings, marmalades, and ice-cream flavorings.

FRUIT AND FLOWERS OF THE PERSIMMON

The flowers of the persimmon range from greenish-yellow to white in color and are somewhat urn-shaped or tubular. The leaves are oval shaped and a shining green. When the fruit is ripe it is orange-colored and deeply wrinkled.

The TRAITS *That Make Up* PERSONALITY

PERSONALITY. Over 50 separate and distinct meanings of the word personality can be found in religious, philosophical, sociological, psychiatric, and psychological writings. The term comes from a Latin word, *persona*. It first meant the mask which Roman actors wore to indicate the parts which they were taking in a play. Soon the word began to have a more general meaning: the role a person was playing. It implied that this role was not a part of the person but was something he could put on or off, as he chose or as the situation demanded. Personality meaning charm or social effectiveness is a popular use of the term today. One hears it in the expressions "He turned on his personality," "He has no personality at all."

Another meaning, in use today, refers to the true characteristics of a person. In that sense, *persona* (and personality) means a lasting set of characteristics which underlie a person's behavior, making his behavior typical and keeping it consistent through many situations. When someone we know acts in an unexpected way, we notice it at once, and we express surprise by saying "I never thought that Joe would do a thing like that."

Consistency of personality forms the basis of the study of personality in psychology, psychiatry, and sociology. In these fields personality is regarded as the fairly stable group of characteristics which determine a person's reactions to situations.

Lasting Personality Characteristics

The most common way of describing the lasting characteristics of a person—his personality—is in terms of *traits*. A trait is a tendency of a person to behave in some consistent manner. Thus, if he is very polite, we may say that he has a strong trait of politeness, meaning that in all sorts of situations he behaves politely. If we say that a person has the trait of aggressiveness, we mean that in a large variety of situations he is consistently aggressive. He is apt to be hostile, to pick a quarrel, to be loud and forward, or to try to dominate others.

The trait is a name description of the behavior of a person as seen by others. When we use a trait name, we do not have to describe all the specific acts which the person has performed. The name implies them all. Furthermore, it implies that in the future the person may be expected to act in the same way. Thus, if a man is described as having the trait of aggressiveness we mean that in the past he has typically acted in an aggressive manner—at home, in class, on the playground. We also mean that in the future and in new situations he will be aggressive—as an employee, as a soldier, as a husband, or as a businessman.

Trait descriptions are useful only when we have agreed on the kinds of behavior included in the trait name. To one person aggressiveness may include a tendency to fight and nothing else. To another the trait of aggressiveness may include loud talk, playing practical jokes, and embarrassing other people. The two are talking about different things and their descriptions of people will not agree. There are numerous traits, and many of them have opposites Here is a list of some pairs:

- Introversion—extroversion
- Dominance—submission
- Aggressiveness—passivity
- Cheerfulness—gloominess
- Kindness—cruelty
- Stability—instability
- Sensitivity—insensitivity
- Independence—dependence
- Friendliness—suspiciousness
- Conscientiousness—irresponsibility

The first two pairs need special explanation. The person who tends to introversion is one who keeps his feelings to himself. He dwells on the meanings of the things he sees and hears. He enjoys his own company and does not mind being alone. Although he may have a few very close friends he does not ordinarily seek out the company of others or feel comfortable in large groups. On the other hand, the extroverted person does not like to be alone. He actively seeks people and talks a great deal, mainly about himself. He accepts experiences without thinking much about them, and his relationships with people tend to be many and superficial. He is often a jovial, hale fellow, known and liked by many people. Sometimes the introvert is described as interested in theoretical and imaginative activities, and the extrovert as a practical individual with little creative imagination.

The traits of dominance (or ascendance) and submission describe the ways people meet their problems and the ways in which they interact with other persons. A dominant person attempts to have his own way, to assert his wishes over those of others. He will always be noticed because he does not take things lying down. He makes his position and his desires clear. He will not be put out of his place in line, and he may try to advance faster than he should. He will try to get other people to do things and will not take no for an answer. The submissive person will not assert himself, feeling that the satisfactions of his own desires or the expression of his own opinions are less important than the demands of other people. He follows rather than leads, and he does not try to advance himself. He may feel inadequate to overcome many of his daily problems. He does not strive for great success because he cannot imagine himself in a position of responsibility. He often attaches himself to a dominant person for whom he may almost be a servant. Actually, through this dominance he can sometimes feel superior or gratify his own wishes.

Personality as the Sum of Traits

The personality can be described in terms of the several traits which a person has by giving a relative value to each. Many students of personality believe that in most people some one, two, or three traits may dominate the other traits. Thus in a person whose dominant trait is aggressiveness, all

other behaviors (and the traits based upon them) will be colored by aggressiveness. In a situation where perhaps a trait of tactfulness or politeness would be appropriate, the person may behave in an aggressively polite or tactful way.

Development of Traits

In very young children, before traits have had much chance to develop, behavior is less consistent than it is in most adults. The child's behavior is controlled by the situations he moves through rather than by the unknown internal processes that underlie traits. His changing behavior may show his changing concern with different features of his activity. He may be playing with a ball. Then his cat enters the room, and his ball is forgotten while he pursues the cat. The cat escapes, and the telephone rings. His interest immediately focuses on that for a time. The person with strong traits and interests persists in what he is doing and how he does it. Only a major or dramatic situational change can disturb the direction or purpose of his behavior.

Traits of personality seem to be developed mainly through social experience. Inheritance and body build may have something to do with traits, but most modern students of personality believe that these factors do little more than make it easier for a person to develop certain traits rather than others. Thus a man who is physically well co-ordinated finds it easier to develop physical prowess than does an awkward, clumsy person. We think of some traits as associated with bodily characteristics but these probably have little to do directly with the body feature. Ordinarily we think of red-haired people as "hot-tempered." The physical make-up of red-haired people does not make them easy to arouse emotionally. Rather, we *expect* red-haired people to be emotional and treat them in ways which lead to the development of a temper.

Most scientists hold that certain needs of the child must be satisfied. Complete agreement on the final list of these needs has not been reached. In addition to the body needs such as hunger, thirst, sex, fatigue, elimination, scientists agree that people need affection, approval, security, acceptance, and status. To help establish these the child develops certain personality traits.

Here is how such needs can motivate the learning of a personality trait. Suppose a father believes that boys should be fighters and that to be a "sissy" is a disgrace. Such a father will not generally give his son affection, approval, security, or status when the boy runs from a fight or is not a leader. On the other hand, the boy is rewarded when he wins a fight, stands up for his rights, plays aggressively at football or baseball, or speaks his mind forcefully in an argument. The boy's needs are satisfied when he behaves in a certain way but they are actually made more intense when he behaves otherwise. These satisfactions, or their lack, are a powerful aid in the development of traits. If a trait continues to help satisfy needs where other children and other adults are concerned it grows stronger and tends to dominate all behavior.

The parent may sometimes be inconsistent in the kinds of attitudes and acts he rewards. Perhaps other children or other adults do not reward the acts which are rewarded at home, or the parents may not agree with each other. The father may reward aggressiveness, and the mother may reward politeness and meekness. These inconsistencies may produce conflict. The child does not know what to do and is unhappy. He may withdraw from one or both of his parents or from his school friends and playmates. Sometimes he resolves the conflict by being different in his behavior at home and away from home. Most children, however, do not experience such severe conflicts, or they resolve them satisfactorily.

The parents are the most important people in the development of the child's traits. They are the first people with whom the young child has contact, and for many years he depends on them to satisfy his needs. The child's friends, other relatives, his teacher, his scoutmaster are also important. All these people help provide the social experiences that contribute to trait development.

TESTING LEADERSHIP AND CO-OPERATION

Bridging a brook, which they were to imagine was a deep canyon, was one of the tests given to candidates for the Office of Strategic Services in World War II. Observers rated the traits of the group and the leader as they worked.

Changing Personality

It is always possible to change oneself on the surface. One can learn manners and how to make conversation. A man can improve his posture and appearance and learn good grooming. A girl may make the most of her "looks" by using beauty aids and dressing attractively. These are important, but they do not immediately or easily change the basic personality traits which have been forming for many years.

The needs which traits satisfy must be understood before the traits themselves can be modified. Often we are

HOW A PROJECTIVE TEST REVEALS TRAITS

In Henry A. Murray's 'Thematic Apperception Test' (published by Harvard University Press) the person being tested is asked to tell a story based on what this picture suggests to him.

not fully aware of our own traits. We tend to think of ourselves in complimentary terms, ignoring unflattering characteristics. If one feels that he must change his basic personality in order to be happy, he should seek expert help from a psychiatrist, clinical psychologist, psychiatric social worker, or a counselor well trained to give it. Many quacks promise a quick personality change at a high price. Most of them have nothing to offer in the way of basic understanding of personality, and some of them may actually do harm.

Testing Personality

There are a number of standard techniques for the study of personality traits and the assessment of the needs which underlie the traits. These four methods are most common:

1. The Interview. Employers often use the interview method to obtain information about the person's skills and job history. They may also try to note traits of personality. Unless the interview is conducted very carefully, it is not a good method for studying personality. Untrained interviewers tend to be influenced by first impressions and unimportant features. Skillful interviewers have been carefully trained for their jobs. They have a systematic list of traits to look for and they have a method for recording their ratings of traits. In their hands the interview becomes a better means of assessing personality. Psychiatrists and clinical psychologists find interviewing useful for the assessment of psychological needs, but they usually require a number of carefully planned interviews to complete such an analysis.

Here is a sample item from a form used to rate cafeteria workers on alertness:

Is this individual quick and active and at all times attentive and ready to take care of customers?

( )	( )	( )
Serves customer within reasonable time	So attentive that customer's wants are anticipated	Seldom ready to serve customers

( )	( )
Tends to allow other workers to serve the customer first	Serves customer quickly

2. Situation Tests. It is sometimes useful to place a person in a situation in which his personality traits may be observed in action. For instance, to observe a man's trait of leadership, he is put in charge of a small group assigned to perform a task, such as bridging a creek. After observation, his leadership ability is compared with that shown by other persons in similar situations. Not all traits are tested by this method. It is expensive and awkward to use. During the second World War it was employed by the Assessment Staff of the Office of Strategic Services as a part of their program of selecting men for hard and dangerous assignments.

3. Paper-and-Pencil Tests. These tests get their name from the fact that the person who takes them writes out his answers. They are usually built on alternative choices, as in the following examples:

a. *Inventories of symptoms of mental and physical illness.* These provide a rough means of finding those persons in a group whose personalities are not well adjusted. Scores on such inventories are first obtained from patients known to be poorly adjusted. If a person makes a score comparable to those made by the patients, he may be maladjusted and need help. However, such scores are often misleading and must be carefully interpreted by an expert before any conclusion is reached.

b. *Inventories of typical social behavior.* These consist of items like this one: "I cross the street in order to avoid meeting someone I know: —Never, —Seldom, —Frequently." The person being tested checks one of the choices. It is believed that persons who check "frequently" on this *and other items similar to it* are giving evidence of a trait of social withdrawal, or introversion. One answer like this is not enough evidence for such a conclusion to be reached. There must be a pattern of answers suggesting the same trait before the person can be said to possess the trait. Such an inventory often contains many items pertaining to several traits, and may yield scores on each. Caution must be used in interpreting such scores because they are subject to many limitations.

c. *Questionnaires concerning past history, attitudes, and interests.* These may deal with the relative desirability of such things as hobbies, kinds of books or movies, and club or class offices. For example, a person may indicate a scientific interest by his history

of scientific hobbies, reading of books on science, belonging to science clubs. Such tests help the person choose an educational or work program consistent with the things that interest him. Here is a sample item from the Allport-Vernon Study of Values test (published by Houghton Mifflin):

When you go to the theater do you, as a rule, enjoy most
—plays that treat of the lives of great men
—ballet or similar imaginative performance
—plays with a theme of human suffering and love
—problem plays that argue consistently for some point of view

4. Projective Tests. Although these tests are sometimes used to reveal traits, they are more often used to investigate a person's needs. Pictures, stories, ink blots, unfinished sentences are typical materials in projective tests. The person is asked to tell a story about a picture, to complete an unfinished story or sentence, or to tell what object an ink blot seems to suggest. These procedures are called "projectives," because the person projects his own meaning into the material. It is believed that the person's needs are partly responsible for these projected meanings. Methods for analyzing the responses given to this type of test are very complex, and only the highly trained psychologist is competent to use them. Such tests are chiefly valuable in assisting with the diagnosis of mental patients and in helping to lay bare the needs of people who want to, or who *must*, *change their personalities.*

Types Versus Traits

Personality tests have revealed one outstanding fact. We often talk about *types* of people and think that persons of one type have little or nothing in common with persons of another type. Personality measurement reveals no evidence that types exist. Rather it suggests that most traits (and needs too) are common to all members of a particular culture; individuals differ mainly in the amounts of these common traits that they possess. Each person has a different amount of each trait, and so the patterns of their personalities are different. Despite common belief, *types* of personality do not exist. Rather, there are only traits of personality which people possess in differing amounts and patterns.

REFERENCE-OUTLINE FOR STUDY OF PERSONALITY AND CHARACTER DEVELOPMENT

THE COMBINATION of traits and behavior patterns which gives individuality to a person is sometimes called *personality* and sometimes *character*. Regardless of the name, the characteristic behavior of the individual, whether good or bad, is largely dependent upon learning. Likewise, many personality and habit patterns can be changed by learning. Undesirable behavior can be avoided and desirable behavior encouraged by practice. To help understand how these habits develop, this Reference-Outline cites both psychological and biographical material.

PERSONALITY AND CHARACTER

I. **What personality is and how it is developed** P-159*a*. See also the Reference-Outline for Psychology
   - A. **Important influences upon personality**
     1. Heredity and environment H-343-8, E-238-40
     2. Habit patterns H-240
     3. Religion and ethics R-101, E-400
   - B. **Personality and character development in children and adolescents** C-239-48, A-22
     1. Individual differences I-113-14
     2. Importance of early social experiences C-240*d*-241
     3. Influence of the arts A-400*a-p*
   - C. **Principles of child training** C-245-8

II. **Emotion and how it affects our lives** E-340-340*b*

III. **Education develops character and personality:** see the Reference-Outline for Education

IV. **Activities outside the school:** athletics A-449; Boy Scouts B-273; Camp Fire Girls C-54; 4-H Clubs F-252; Future Farmers of America F-326*a*; games G-8; Girl Scouts G-113; hobbies H-387; juvenile organizations J-368*a*; leisure L-158; nature study N-45; parks and playgrounds P-86*a*; play P-315; reading and use of libraries R-82, L-269, L-204; vacation activities V-421; Y.M.C.A. Y-342; Y.W.C.A. Y-343

V. **Lasting personality characteristics—traits** P-159*a*: development of traits P-159*b*

VI. **Changing personality** P-159*b-c*

VII. **Tests of personality and character** P-159*c-d*, I-175

DESIRABLE CHARACTER TRAITS WITH SUGGESTED READINGS

I. **Reliability:** John Quincy Adams A-14; Aristides A-338; Simón Bolívar B-221; Robert Borden B-252; Georges Clemenceau C-342; George Goethals G-129; Abraham Lincoln L-245; Jan Christiaan Smuts S-202; George Washington W-16

II. **Judgment:** Charles Francis Adams A-12; Aristotle A-339; Goethe G-129; Charles Evans Hughes H-438; John Locke L-288; John Marshall M-103; Plato P-315; Socrates S-224

III. **Initiative:** Susan B. Anthony A-262; Luther Burbank B-356; John Cabot C-8; Christopher Columbus C-416; Thomas Edison E-235; Benjamin Franklin F-279; Galileo G-5; George Frederick Handel H-257; Elias Howe H-436; Henry Hudson H-437; Thomas Jefferson J-330; Edwin Landseer L-93; Guglielmo Marconi M-93; Samuel Morse M-395; Isaac Newton N-193; James Watt W-74

IV. **Industry:** Andrew Carnegie C-124; James Garfield G-20; Herbert Hoover H-419; Jack London L-297; Jean Millet M-255; Robert Louis Stevenson S-393

V. **Self-control:** Roald Amundsen A-237; John Bunyan B-354; Richard E. Byrd B-373; Thomas Carlyle C-122; Sidney Lanier L-100; Charles A. Lindbergh L-252; Horatio Nelson N-109

VI. **Punctuality (in public service):** fire department F-81; lifesaving service L-225; newspapers N-186; police department P-352; United States Coast Guard C-371; Paul Revere R-119

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VIII. **Social-service activities:** see the Reference-Outline for Sociology

IX. **Personal and social habits:** diet F-211; fresh air H-304; health H-300; sleep S-198; teeth T-35; etiquette E-404; conversation C-458; letter writing L-171. See also the Reference-Outline for Physiology, Health, and Medicine

X. **Character education in other times:** ancient Greece E-243-6; knights of the Middle Ages K-55; doctrines of Rousseau E-255-6, R-236

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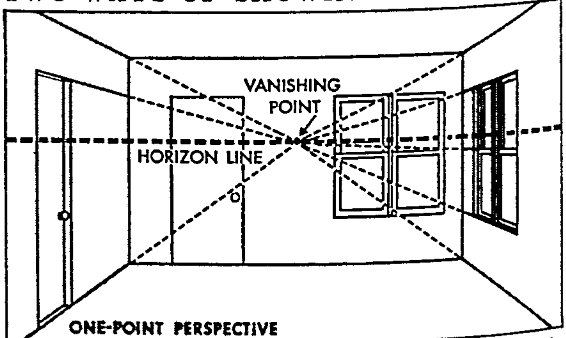
PERSPECTIVE. A flat (plane) surface has only two dimensions—length and width. The art and science of drawing a picture on a flat surface so that a third dimension—depth—seems to be present is called perspective. *Linear perspective* produces the illusion of depth through the use of converging lines. The principle of linear perspective can be seen by looking down a railroad track. The rails, which we know are parallel, seem to gradually draw together until they meet and disappear into a single *vanishing point.* Similarly, the trees and telegraph poles flanking the track seem to diminish in size until they finally disappear.

In drawing this scene, an artist would sketch in a line (not necessarily present on the final drawing) which would be level with his line of sight. This line is the picture's *horizon.* The vanishing point always falls on the horizon. Such a depiction makes use of parallel, or *one-point,* perspective.

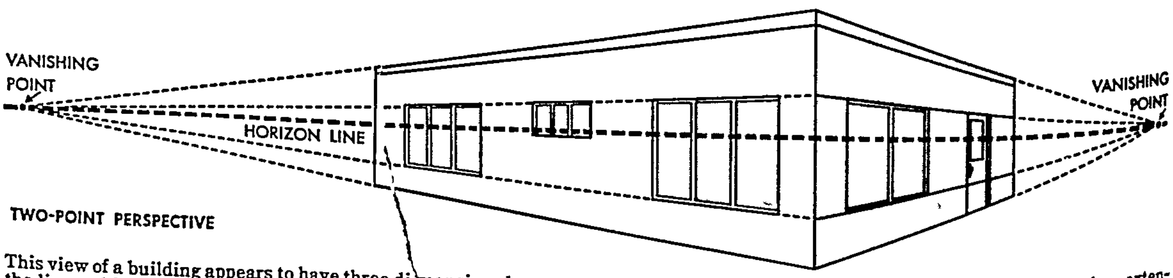
Angular, or *two-point,* perspective involves the use of two vanishing points. The drawing of the building on this page illustrates this method. Notice that both vanishing points lie on the same horizon. A different kind of perspective treatment is *aerial perspective.* This is what painters use when they achieve an appearance of depth by modifying colors and tones and by making receding objects in the picture less distinct.

The ancient Egyptians and Assyrians either did not know the principles of perspective or they did not care to use them. Greek and Roman painters used one-point perspective, but the art was apparently forgotten in the Middle Ages. The paintings of Giotto and other early Renaissance artists still had a flat, two-dimensional look. Finally the principles of perspective were rediscovered by the painters Albrecht Durer and Leonardo da Vinci, the architects Filippo Brunelleschi and Leone Alberti, and others.

TWO WAYS OF SHOWING PERSPECTIVE



The appearance of depth in this room is achieved by having the horizontal lines on the side walls (which are actually parallel) converge so that their broken extensions meet at the vanishing point. The broken horizon line is at the viewer's eye level.



This view of a building appears to have three dimensions because the lines which are horizontal in reality are here shown as angling toward their respective vanishing points. The broken extensions show where the lines would meet along the horizon line.

PERU—*Ancient* GLORY *and Modern* PROGRESS

PERU. Long before Europe knew of the existence of a New World, Peru had a thriving civilization and culture of its own. The Incas had conquered other Indian tribes and had set themselves up as the ruling group. Like the Romans, they had a talent for political organization; they were also skilled builders, farmers, and craftsmen (*see* Incas). In 1532 the ruthless Pizarro and his raiding Spanish conquistadors plunged across the shoulder of South America and found their way to Cusco, the Incan capital. The Spaniards found a vast treasure of stored gold and silver; they also found a weakened political structure, which enabled them to conquer swiftly and savagely (*see* Pizarro). Peru has never recaptured the prosperity it enjoyed before the Spanish conquest.

THESE TWO ARE "CHUNCHOS"

"Chunchos" is merely the Spanish name for the people of the eastern "montaña," or forest zone, of Peru.

The Land of Peru

This land on the western coast of South America has a wide diversity of mineral wealth, soil, and climate. Geography as well as lack of modern industrial methods has made progress difficult, however. The Andes sweep through Peru in a massive wall, almost unbroken by low passes. Transportation between the interior and the coast is a continuing problem, and many of the mineral and forest resources remain untapped. Along the Pacific coast, where the chief money crops are grown, large areas await irrigation, for here the annual rainfall is insufficient for productive and profitable agriculture.

Some progress is being made. Great enterprises, such as the petroleum-refining industry, have been launched with the aid of foreign capital. All forms of transportation are being improved, and irrigation is being extended. Rivers that flow swiftly down from the steep Andean ranges are being harnessed to produce hydroelectric power.

Unlike the Atlantic side of South America, much of the Pacific side—including Peru—is an arid, treeless coast strip 20 to 30 miles wide. It is broken only by a few green river valleys at wide intervals. Rain rarely falls in this almost barren region, for the towering Andes intercept the moisture-laden trade winds from the southwest and catch all the rain on the eastern slopes.

For much of the year the coast is bathed by heavy mists, caused by the cold Humboldt, or Peruvian, Current, which sweeps up from the south. As it is all along the Pacific coast of the American continent, good harbors are few, and ships must make long voyages between ports.

Above this narrow coast strip are three ranges of the Andes Mountains. They form a high wall between the coastal zone and the vast forest region drained by the Amazon. Peru thus falls naturally into three zones: the coast zone; the *sierra*, or great tableland lying in the valleys between the three ranges of the Andes; and the *montaña*, or river and forest zone, on the eastern slopes. The coast zone comprises about one tenth of the total area; the sierra about a fourth; the forest zone the rest.

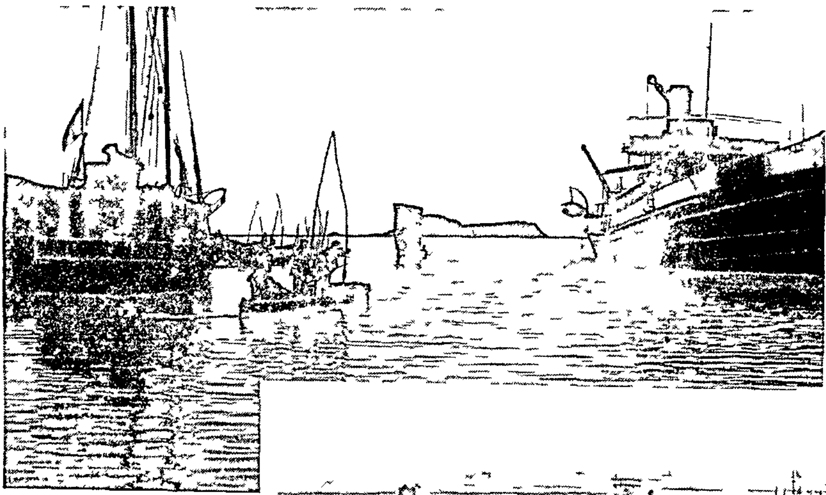
Boundary disputes with its neighbor Ecuador, involving a vast tract east of the Andes, were arbitrated in 1942. The larger part was awarded to Peru, bringing its area to about 545,000 square miles. It has a coast line about 1,400 miles long, and the country's average width is 800 miles. An enormous river system breaks through the eastern chain

THE STRIP BETWEEN SEA AND MOUNTAINS

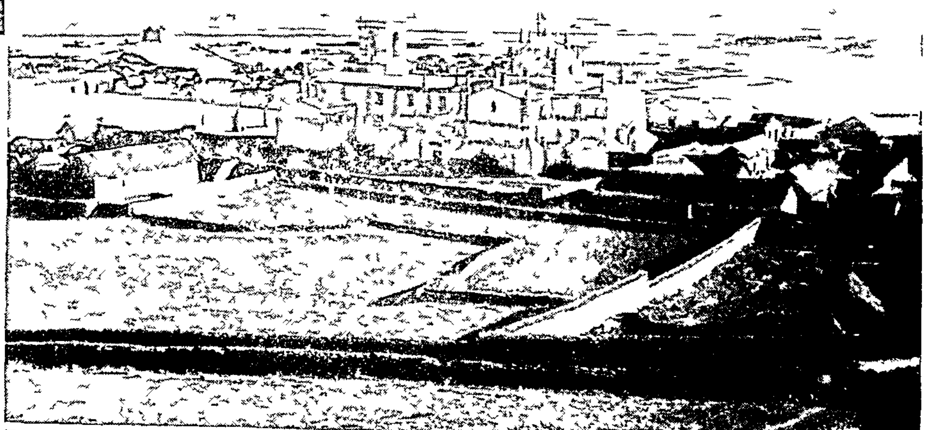
This is one of the two important railway lines of Peru. It runs from the coast by way of Arequipa to Lake Titicaca and to Cusco, chief city of the Incas. The other railroad runs from Lima eastward into the Andes. Both of these lines cross the barren coast strip, which looks as if it could support no life of any kind, but they also tap the rich mineral resources of the mountains.

of the Andes and flows through impenetrable jungles to form the Amazon. Of these rivers the greatest is the Marañon, generally taken to be the true source of the Amazon.

ON THE ROOF OF THE ANDES



Lake Titicaca, more than 12,500 feet above sea level, is the highest body of water in the world traversed by steamships.



The branches of Peru's Southern Railway meet at Juliaca, which lies more than two miles above the sea in the Andes, west of Lake Titicaca. The weather here is so cold that only barley and potatoes can be grown. Trade in cattle, wool, and hides is the town's chief means of support

The three divisions of Peru differ so widely in climate, products, and population that they form in effect worlds to themselves, and the inhabitants of one find it difficult to adapt themselves to conditions in the others. Difficulties of communication isolate one region from another Many of the upland cities are accessible only by airplane or mule trails. The vast, thinly settled forest region has few routes of travel except those furnished by its many rivers.

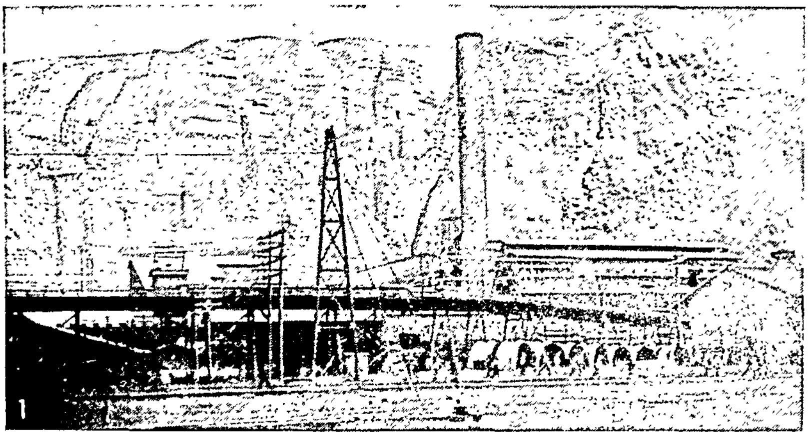
What More Water Would Do for Peru

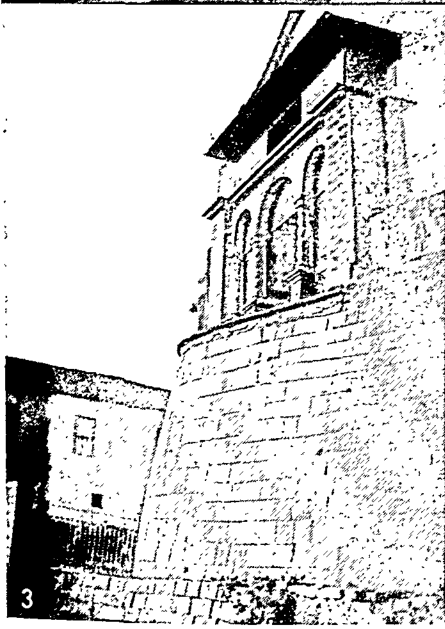
The coast towns, with the valleys of the few rivers that flow into the Pacific, are the center of the commercial, intellectual, and political life of Peru In the narrow valleys of the coastal rivers the land when irrigated is wonderfully fertile. In this region cotton and sugar (Peru's chief export crops) and rice and tropical fruits are grown, though only a small fraction of the arable land is under irrigation.

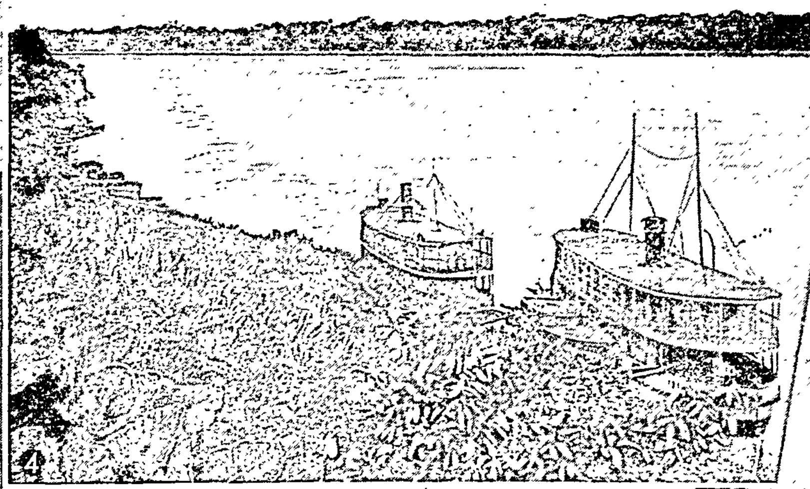
The plateaus and valleys of the sierra, with their more bracing climate, contain a great extent of fertile soil, but much of it can be cultivated only by terracing the steep hillsides as did the ancient Incas. Coffee, corn, wheat, barley, potatoes (which came originally from this part of South America), alfalfa, coca (a shrub from whose leaves cocaine is extracted) flourish at various levels from 5,000 to 12,000 feet. Through the entire length of the sierra region are immense grazing lands, on which cattle and sheep are raised, as well as alpacas, and the most useful of all the Andean animals, the llamas. The wools of these animals and of the vicuña, which lives wild at great heights, are used for clothing and are also exported in considerable quantities. (*See* Alpaca, Llama)

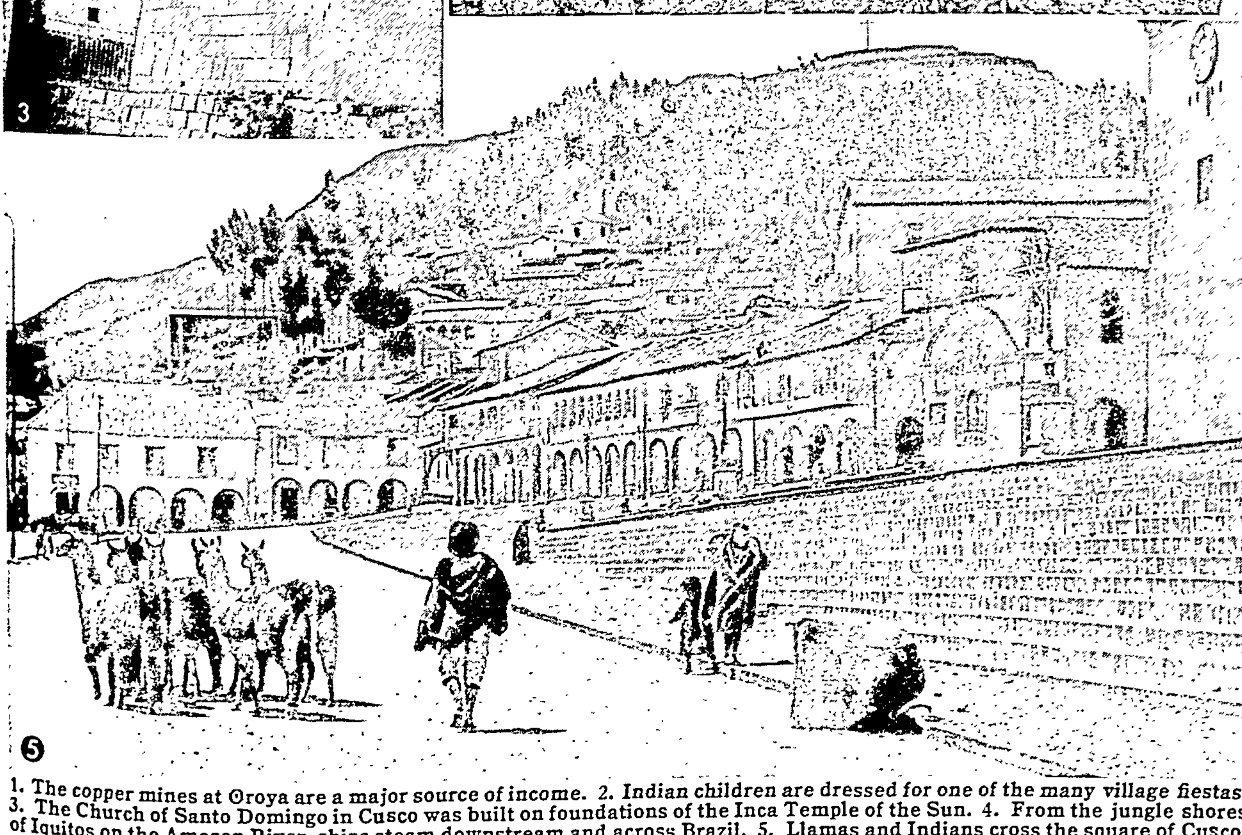
On the temperate eastern slopes of the Andes and in the tropical river valleys are vast tracts of territory, for the most part undeveloped, on which abundant harvests of almost every known crop could be raised in a remarkably short time. "It is sufficient to cut down and burn the brush and scratch the soil and sow with any seed, to recover returns of a hundred for one," says one authority. Most of the products of the tropics—sugar cane, cacao (the source of chocolate), cotton, and coffee—are here cultivated, but the difficulty of transportation greatly retards development The forests of valuable woods in this region cover more than half of the area of Peru. The rubber forests appear inexhaustible but are difficult of access; and the rubber trade has left an indelible stain on the country because of the unspeakable cruelties inflicted on the native workers in the Putumayo region. Another famous product is quinine, made from the cinchona tree, which used to be known as "Peruvian bark"

The mountains contain extensive deposits of copper, silver, lead, gold, vanadium, coal, zinc, sulphur, and other minerals The production of petroleum, which is found near the seashore, exceeds in value that of all other natural deposits.



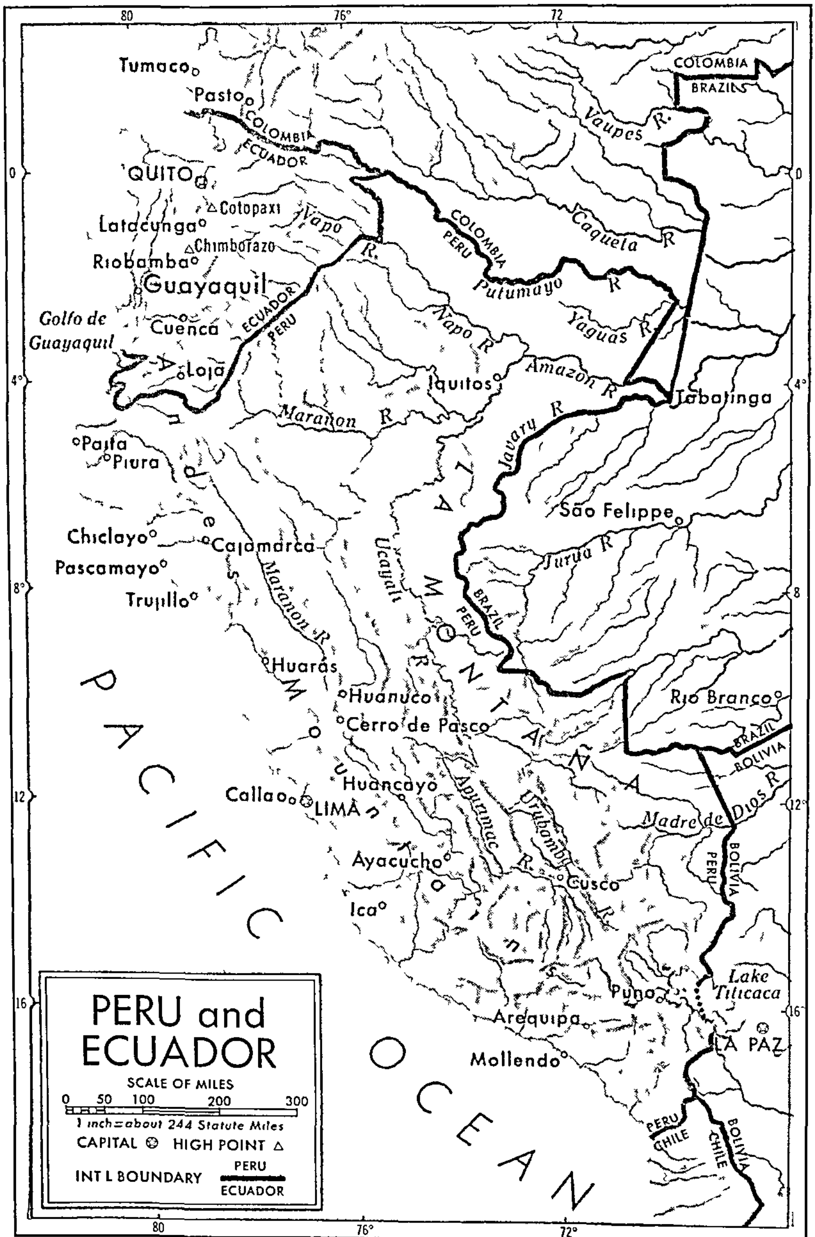






1. The copper mines at Oroya are a major source of income. 2. Indian children are dressed for one of the many village fiestas. 3. The Church of Santo Domingo in Cusco was built on foundations of the Inca Temple of the Sun. 4. From the jungle shores of Iquitos on the Amazon River, ships steam downstream and across Brazil. 5. Llamas and Indians cross the square of Cusco, former capital of the Inca empire. Both the square and the aged church were heavily damaged by an earthquake in 1950.

To open up these agricultural and mineral resources, good transportation is required. It once took 30 days to travel by rail, mule trail, and river from the capital Lima, near the coast, to Iquitos, near the source of the Amazon—a distance of only 1,224 miles.



Three mighty ranges of the Andes separate Peru's narrow and dry coastal plain from the moist jungle of the interior. The headwaters of the Amazon rise in these mountains.

In 1943 the trip was reduced to five days by the opening of a 522-mile motor highway to Pucallpa on the Ucayali River, whence the traveler proceeds by steamship to Iquitos. About 17,000 miles of highways are now open. Peru's short railways total some 3,000 miles and there are 4,000 miles of navigable waters. Air travel is increasing rapidly. The loftiest steamship route in the world extends across Lake Titicaca between Peru and Bolivia.

Cotton and sugar rank first among the manufactures of Peru, which are not extensive. High-speed mills of the latest type greatly increase production. The cocaine from Peru largely supplies the world's demand. Lima, capital and largest city, manufactures cotton and woolen textiles, sugar, and tobacco (*see* Lima). Arequipa, the third largest city, has cotton and flour mills, chocolate factories, and tanneries. The chief ports are Callao, six miles west of Lima, and Mollendo in the south. Callao, the gateway to Lima, has one of the best-equipped harbors in South America. Cusco was the chief city of the Incas, who got their gold from the mines and streams in the region. Cerro de Pasco, northeast of Lima, is one of the highest and largest mining camps in the world. Gold and silver are produced as by-products of copper mining, the chief industry of the district. Near Chimbote, north of Lima, a large hydroelectric plant provides power for a flourishing steel industry and irrigation for extensive areas of formerly unproductive farmlands.

The population was 6,207,967 by the 1940 census. A 1949 estimate gives 8,240,000. About half the people are pure Indians. The others are whites or *mestizos*, of mixed white and Indian blood.

Bolívar Drives Out the Spanish Conquerors

Peru contains many interesting remains of ancient Indian civilization (*see* Incas). Buildings of immense size, and beautiful pottery and implements testify to the high degree of development attained. From its conquest by Pizarro in the 16th century (*see* Pizarro) until its erection as an independent republic in 1821, Spain's rule over Peru was most barbarous. In 1824 a liberating army from Colombia under Gen. Simón Bolívar finally rid Peru of Spanish rule. Disorders followed and it was not until 1844 that a stable government was set up. With but two exceptions there was peace in Peru from that date until 1879, when it became involved in a war with Chile (*see* Chile). Peru was defeated and lost the province of Tarapacá, also Tacna and Arica for a period of ten years, when a popular vote was to decide which country should have permanent control. However, for a number of reasons, the vote was never taken and the

situation became serious. In 1929 an agreement was reached. Chile kept Arica and the Arica-Tacna Railroad. Peru received Tacna, with port rights in Arica.

According to the constitution, the president, the senate, and the chamber of deputies are all chosen by the vote of literate males over 21 years of age. Power is strongly centralized in the hands of the president. Catholicism is the state religion. Elementary and secondary education are free, but about three fourths of the people are illiterate. (For Reference-Outline and Bibliography, *see* South America.)

PETER, SAINT. "Follow me, and I will make you fishers of men," said Jesus to the two sturdy fishermen, Simon, called Peter, and Andrew his brother. Without hesitation the two men rose up, pulled their nets into the ship, climbed over the side, and went away with him.

Peter became the most prominent of the Twelve Disciples. In the meager accounts given in the New Testament of the lives of these men who went about with Jesus preaching and doing good, Peter's name is most often mentioned. With James and John, he formed a little intimate group around Jesus, and with them was present at some of the great incidents of Jesus' life—the transfiguration on the Mount and the last night before his crucifixion.

SAINT PETER, AS DONATELLO SHOWS HIM

This statue in Florence portrays Saint Peter as leader of the Apostles. His left hand holds the Gospels, while his right hand holds the key, symbol of the power to bind and loose sin.

It was St. Peter, according to the Gospel of St. Matthew, who first gave voice to belief in the divinity of Jesus—"Thou art the Christ, the Son of the living God." Peter was generous-hearted but over-impulsive; and he it was who, when men came to arrest Jesus, lifted his sword, although he was only one against a crowd, and smote wildly at the man nearest him, cutting off his ear. Yet only a few hours afterward, when Jesus had been led off to the house of the high priest, Peter denied that he ever had known him. Later he bitterly repented his denial, and he was the first of the Apostles to whom Christ appeared after his resurrection. At a later meeting Jesus gave him the command: "Feed my lambs."

Peter, thus assured the Master still trusted him, grew daring and courageous, and became the great teacher in the early days of the church, preach-

ing throughout Palestine, performing miracles of healing, and enduring great hardships and persecution. That he worked in Rome for a time is accepted by Catholics and many leading Protestant scholars. Roman Catholics count him as the first bishop of Rome and the first pope. His claim to the position of head of the church is based also on the words of Jesus to Peter: "Thou art Peter, and upon this rock [Greek "petros," meaning either "rock" or "Peter"] I will build my church." After many years, according to tradition, the Romans took him prisoner in the reign of Nero and crucified him. Peter, impetuous as of old, declared he was not worthy to be crucified as was his Master, and asked to be crucified head downward, a request which the Romans readily granted.

The First Epistle of Peter was written by him; *but the evidence as* to the Second Epistle is not so clear. It is believed that the Gospel of Mark is derived from Peter's accounts of the life of the Master.

PETER THE GREAT (1672–1725). Russia has two faces: one is turned toward Asia; with the other it looks out on Europe. Its western face has never lost the features given it by the greatest of the Romanov family, Peter the Great.

PETER THE GREAT
The Creator of the Russian Empire

In Europeanizing Russia, Peter owed something to his predecessors, who had made contacts with the Western world and permitted traders and colonists to come into Muscovy, as Russia was called, and to settle in the outskirts of Moscow itself. It was to these colonists and to his French tutor that the boy Peter, neglected at court, turned to learn in the reigns of his older half-brother and sister.

In 1689 the ruthless boy of 17, a man in energy and decision, shut up in a convent the half-sister who had been acting as regent, and disregarded the feeble-minded half-brother who was supposed to be joint ruler with him. It seemed nothing short of insanity for a ruler to attempt to beat down the walls of tradition, custom, culture, religion, and geography that shut Russia off from the Europe of Louis XIV's day. But Peter did it almost single-handed. Brutal, barbaric, without scruple, without even a memory of kindness or conscience or morals, he whipped Russia into a place in the circle of European powers.

Nothing could stop this volcano of human energy, and he stopped at nothing to reach his ends. He was as if driven by an inner fire and his activity was unceasing. He reformed the army, began the navy, crushed the church into subjection, introduced new taxes, forced European ways and dress on his reluctant nobles, furthered the introduction of western education, products, and processes, and sent abroad Russians to learn, while he brought in western Europeans to teach. Drunk or sober, he spared neither himself nor his people.

Peter not only drove but he led. He tried to learn everything himself, whether it was shipbuilding or tooth-pulling. He longed especially for a direct view of a civilization that would rouse his land from its isolation and Asiatic seclusion. So in 1697 he visited Europe, *ostensibly as a subordi*nate member of a group of Russians who were to learn western ways; but it was Peter who did the learning. Prussia, Hanover, and Holland were visited, and in the latter country the czar himself worked in a shipyard. Three months were spent in England, and several hundred English engineers and artisans were added to the party. When the Russian party left, the English cleaned out the residences assigned them much as they would clean a pigpen. Louis XIV avoided such a visitation by insisting that, as Peter was traveling incognito, he could not give him a royal reception. Peter therefore traveled on to Vienna; whence he was recalled by a plot of the royal guard (Streltsi) aided by the Old Russian party. After crushing the rising, Peter divorced his wife, who was thought to be in the plot.

The Founding of St. Petersburg

In 1703 he founded a new capital at St. Petersburg (later Petrograd and now Leningrad), near the Baltic at the mouth of the Neva, which he had won from the Swedes (*see* Leningrad). On a later visit to Europe, in 1716-17, all the reactionary forces in Russia rallied behind Peter's son, Alexis. The revolt was in vain, and the son died in prison from tortures.

In his external policy Peter determined to secure for Russia ice-free outlets to the sea, which he called "windows toward Europe." His first blow fell on Turkey in in effort to secure a foothold on the Black

Sea. In 1696 he captured Azov, at the mouth of the river Don, only to lose it 15 years later.

In the meantime he had challenged Sweden, the greatest military power of the north. In that day Sweden controlled the eastern end of the Baltic, Russia's other possible outlet. From 1700 to 1721 it was a duel between Peter the Great and Charles XII of Sweden. Peter's raw recruits were beaten at first, but they learned and Peter learned. Charles was even more rash and impetuous than Peter and would not learn. At the battle of Poltava (1709), in southern Russia, Peter won a decisive victory. The war continued, each leader drawing to his support the other's enemies. Peter triumphed in the end. The peace of Nystad, in 1721, made Russia a Baltic power, with a shore line on the south of the Gulf of Finland. A year later a war with Persia gave him a foothold on the Caspian Sea.

In 1712 he had married his mistress. Before he died in 1725 he made her his successor as Catherine I. Probably no ruler has ever left a greater impress on the land over which he ruled than did this czar, half brutal barbarian and half benevolent despot.

PETREL. Mother Carey's chickens, as the petrels are called by sailors, wander over all the oceans of the world. They live entirely on the sea, except for a brief nesting season on rocky coasts and islands. Following every ship, weathering every gale, these strong-winged little birds are the pets of all seamen.

The name petrel means "little Peter." It was given to the birds because their habit of "walking on the water" recalls the biblical story of the apostle Peter. The birds, however, always do their "wave-walking" upheld on spread wings. The feat can scarcely be called walking, in the strictest sense.

Strange stories and superstitions are connected with the petrel. They are supposed by many to be under the protection of the Virgin Mary. Others believe that each bird represents the soul of a sailor lost at sea. Seamen believe that when they appear, a storm will follow. Hence a common species is called the storm petrel.

Petrels vary in size from the storm petrel, which is five and one-half inches in length, to the fork-tailed petrel, which is nine inches long. The general color is brown or grayish-black; some species have a patch of white feathers at the base of the tail. Generally but one egg is laid, in a rocky crevice or in a burrow in some bank. The birds feed on small water animals or on any refuse cast overboard from ships. The nestlings are apparently fed only at night.

One species of petrel, the cahow, is found only in the Bermudas. It was believed to have been wiped out between 1609 and 1621 when famine forced the English settlers to live on the birds and their eggs. Dead specimens picked up in 1906 and in 1935 raised the hope that the cahows had escaped extinction. In 1950 a party led by Dr. Robert Cushman Murphy of the American Museum of Natural History found the first living birds to be observed in 330 years. The scientists examined the burrows in one of the rocky Bermuda islets and captured five birds. They banded the birds with United States Fish and Wildlife Service leg bands and released them.

Petrels belong to the order of tube-nosed swimmers (*Procellariiformes*). They are grouped in two families, the *Procellariidae,* which includes the fulmars, shearwaters, and cahow, and the *Hydrobatidae.* Scientific name of storm petrel, *Hydrobates pelagicus;* of fork-tailed petrel, *Oceanodroma furcata;* of cahow, *Pterodroma cahow.*

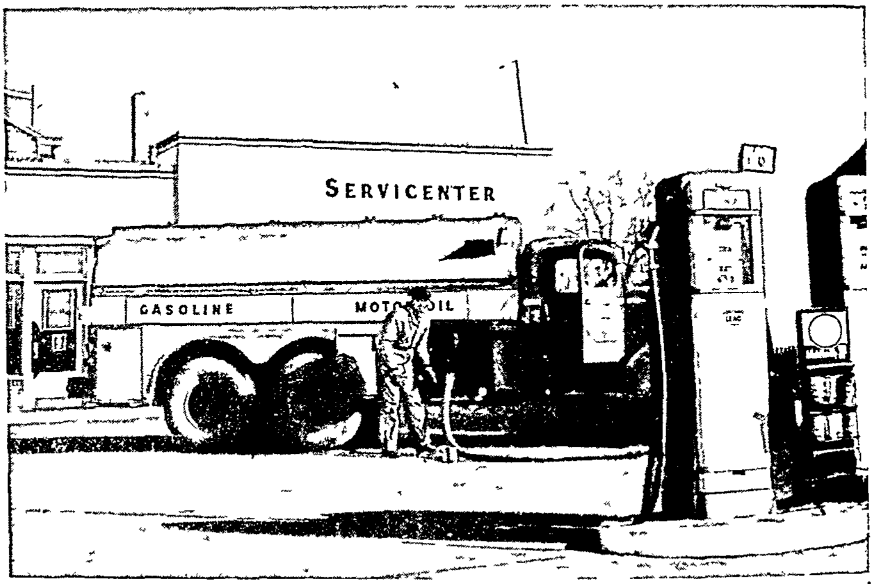
PETRIFIED FORESTS. Over large areas of the western United States and elsewhere are forests that have been turned to stone. In some instances the growing trees were buried by great showers of volcanic ash. Water, carrying silica and other minerals, trickled through the overlying stratum, and the plant tissues were replaced by these minerals. So complete was this exchange that the microscopic structure of the trees is perfectly preserved. In time, erosion partially uncovered these forests. Many of the trees, stripped of bark and branches, are scattered over the ground, but a few petrified trunks stand where the trees once grew. (*See* Fossils; National Parks.)

AN ANCIENT TREE MOLDED IN STONE

One of the most curious of nature's miracles is the transformation of wooden objects into stony ones. In this petrified log the wood has been replaced throughout by mineral matter. But the stone still shows the structure of the wood, even to microscopic details in the heart.

PETROGRAD, RUSSIA. When Peter the Great founded his new capital in 1703, he named it St. Petersburg. During the first World War the Russians disliked the German sound of that name and changed it to Petrograd. In 1924 they renamed it Leningrad in honor of Nikolai Lenin. (*See* Leningrad.)

WEALTH *from* PETROLEUM *and Its* PRODUCTS



Wherever motorists go across the nation, service stations like the one in this picture furnish gasoline, oil, repairs, and all sorts of motoring aids. A tank truck from a central distributing point is supplying the station with thousands of gallons of petroleum products.

PETROLEUM. Billions of wheels in the world are turning because petroleum fuel supplies the power. They turn without noise or wear because of petroleum lubricants. Automobiles aircraft, ships, and trains depend on petroleum. So do engines and machines that are used in industry and agriculture. Petroleum heats buildings and provides ingredients for countless manufactured items, such as synthetic rubber, plastics, paints, medicines, and insecticides. In wartime petroleum is even more vital. It provides fuel for military vehicles and goes into munitions and such explosives as jellied gasoline.

The petroleum industry spans the globe. Derricks in east Texas fields are similar to those in the oil-rich deserts of Saudi Arabia. Refineries in Ploesti, Rumania, are counterparts of gleaming structures in Indiana and New Jersey. Many oil companies are international, and a "roughneck" (a skilled oil-field worker) from Texas may work with a crew of Canadians one year and Arabs the next.

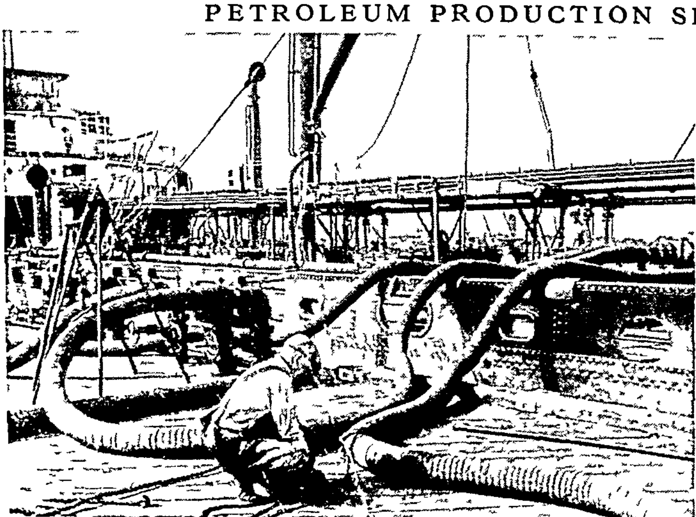
Where Is the World's Oil?

Many countries in the world have some petroleum. Only a few have enough to fill their own needs and to supply others. Thus the needs of oil-poor nations have created a permanent problem which lies at the root of much international dissent.

A nation's underground petroleum is called its *reserve.* Estimates of these proved (discovered) reserves are based on how much of what lies below ground can actually be taken out. In various countries, estimates of proved, producible reserves have grown yearly despite heavier production and use. This increase comes from discovery of new fields, expansion of partly developed fields, improved methods for drawing more oil from wells, and deeper drilling. New producing fields are being discovered constantly, and large areas remain to be fully tested.

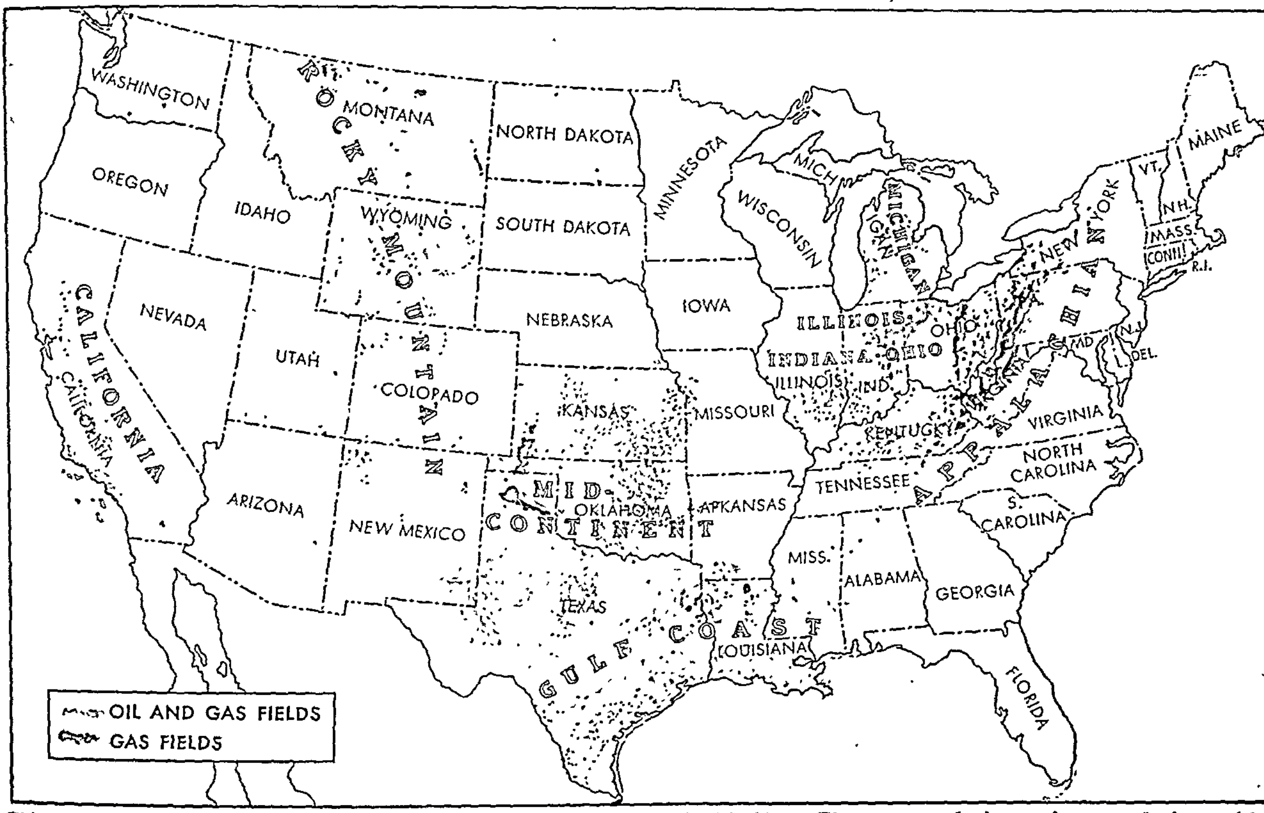
Despite having consumed far more oil than any other country, the United States has the greatest proved reserves in the world. Its reserves are still

PETROLEUM PRODUCTION SPANS THE GLOBE



Petroleum is vitally needed everywhere, and nations with abundant reserves must supply others. In the picture at the left, a huge tanker takes on a cargo at the port of Los Angeles for a destination in oil-poor India. The great demand also leads to production in out-of-the-way localities. At right, a turbaned derrick man helps drill a well in the Hasa district in Saudi Arabia.

OIL AND NATURAL-GAS FIELDS OF THE UNITED STATES



This map shows the distribution of the oil and natural-gas wealth of the United States. Where oil and natural gas are found together, the areas are marked in orange. Natural gas alone is marked in blue. The great producing regions are designated in large type on the map. From these areas a vast network of pipelines leads to refineries and consumers all across the nation.

growing. The current estimate is over 30 billion barrels. However, the countries of the Middle East together outrank the United States. Estimated reserves in Bahreín, Saudi Arabia, Iran, Iraq, Kuwait, Turkey, and Qatar are as high as 62 billion barrels.

New discoveries in Alberta bring the Canadian estimate to 1¾ billion barrels, while Mexico has about 1⅔ billion. Venezuela has nearly 10 billion barrels. Its neighbor, Colombia, has about 500 million. Russia has perhaps 6½ billion barrels, located largely in its southern areas. Outside of Russia, Europe is poor in oil. Rumania is the only nation with oil to spare beyond its own needs. It has about 400 million barrels of reserves. The richest reserves in the Far East are in the Republic of Indonesia, with 1½ billion. The rest of eastern Asia has little oil. Africa is even poorer. The present-day world total reserve is about 115 billion barrels.

Increased consumption may finally reduce reserves sufficiently to produce a world shortage. Therefore the search for new sources of oil is endless. Geologists are constantly finding new reserves underground and in localities once thought unworkable. Tidelands along the Gulf of Mexico and California coasts are yielding rich stores of oil. Oil-bearing shale in the Colorado, Utah, and Wyoming mountains offers an additional supply. Conservation methods and laws are increasing. Moreover, if the supply should fail, chemists are already producing practical quantities of oil from coal with hydrogenation processes.

How Petroleum Was Formed

PETROLEUM began to form millions of years ago. During the long ages of earth history before the coming of man, the oceans washed over parts of the continents many times and formed shallow inland seas. Geologists say that 15 times in the past 500 million years North America had great stretches of land area covered by oceans.

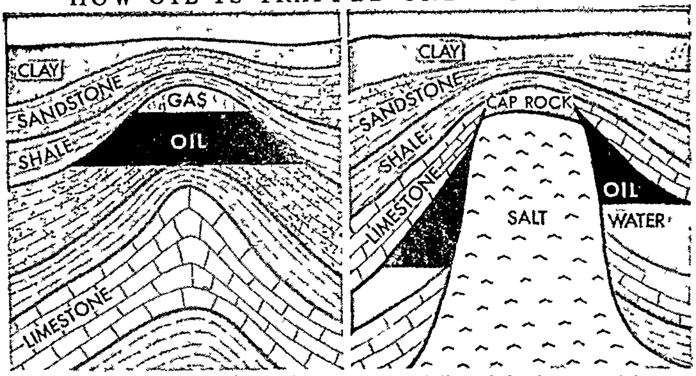
Tiny creatures lived in the water, and a tangle of strange-looking plants grew from the rich soil of the ocean floor. When the sea animals and plants died, they sank to the bottom and were slowly covered by silt. New generations took their place. Periodically the sea waters receded. Wind and rain laid down layers of sediment and sand over the plant and animal matter. Through the ages the sediment hardened into rock, called *sedimentary* rock. Beneath it the decaying matter was changed by pressure from above and by earth heat from below. Scientists believe that bacteria may have aided the change.

Slowly the matter changed to a thick, waxy substance. Finally it became an oily liquid that lies embedded in porous sand or shale. The ancients found this oil seeping up through cracks in the earth, usually from beneath a broken layer of rock. So the Romans named it petroleum, from the Latin words *petra* meaning "rock," and *oleum*, meaning "oil."

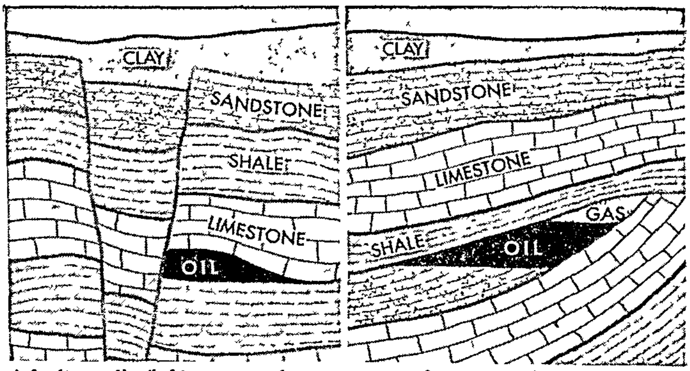
Where Oil Hides Beneath the Earth

Oil may move from one place to another in the layers of sedimentary rock which lie beneath shale or

HOW OIL IS TRAPPED UNDERGROUND



Oil hides in these rock formations. The anticline (left) is caused by an upfolding of rock strata. The salt dome (right) is a giant plug of rock salt that forms a trap between itself and surrounding rock.



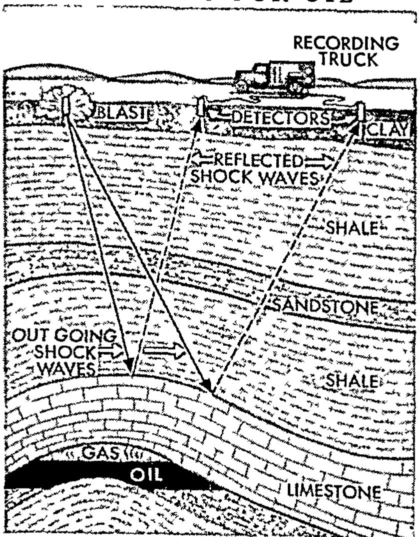
A fault, or slip (left), occurs when a stratum of porous rock moves against a layer of impervious rock. This creates a pocket for oil to collect in. At right is a stratigraphic trap. No change of rock formation occurs here. Rather, a ring of sand or porous rock hardens to hold the oil.

other impervious rock. This hard, nonporous rock forms a barrier which retains the oil in the sedimentary formation. Such barriers are called *oil traps*. They act as dams that collect "pools" of oil, salt water, and natural gas. To get a supply of petroleum it is necessary to find an underground pool caught by a rocky trap.

Some oil traps are shown in the pictures on this page. The *anticline*, or *dome*, is one of the commonest. It is formed by a sudden upfold in the rock layer. Oil is trapped beneath the anticline by its walls of nonporous rock slanting down on either side of the oil-bearing sand or rock.

Salt plugs also form oil traps. In such regions as the Gulf Coast, giant plugs of rock salt have heaved up toward the surface, pushing oil-bearing sands ahead and arching up the overlying rock. The rock above and around the plug forms an oil barrier. Salt plug formations are often found in underwater tideland regions.

SOUNDING FOR OIL



This seismograph seeks oil traps. A blast sends waves below ground. When they hit a hard layer of rock they reflect strongly. Reflections are recorded at the truck.

A *fault*, or *slip*, results from a break in the earth's rock crust. When the fault throws a porous layer of rock against a solid mass, a natural oil trap is formed. A *stratigraphic trap* is formed when for some reason, part of the oil-bearing rock becomes nonporous and prevents the oil from oozing away. No pronounced rock folding is present. These underground oil traps range in area from a few hundred feet to many miles across. In nearly all of them, natural gas and salt water are also held. The gas and water provide the pressure that shoots the oil to the surface when the well is drilled.

Searching for Oil

It is impossible to tell from the earth's surface just where oil may lie below. Oil geologists can find rock formations which may be oil traps by a delicate and specialized kind of detective work. The aerial camera is one of the tools used for exploring a prospective oil field. From aerial photographs the geologist knows where the land rises and falls. He then has surveyors make accurate measurements to develop a surface map of the field.

He must also draw a *subsurface* map of the field. To do this he must know how underlying rock layers rise and fall. His most accurate device is the *reflection seismograph*, shown in a picture on this page. This is a miniature of the seismographs used for detecting earthquakes. It works on the principle that harder rock layers will reflect sound waves more strongly than softer strata. The varying strength of the recorded reflection indicates the nature of the rock. Another device is the *gravitometer*. This "weighs" the rock below it. Where the pull of gravity is greatest, underground rocks are arching upward. Where the pull lessens, there is a decline in the structure. The *magnetometer* works something like the gravitometer. It records the varying magnetic pull of rising and falling subsurface structures. Chemical tests of the soil above may give additional clues.

Drilling for Oil

THE TEST of the geologist's work lies in drilling a well. A testing, or *discovery*, well in unproved territory is called a *wildcat* well. It is one of the most expensive gambles in the world. The cost of drilling a deep well may run as high as $500,000. If the well is a dry hole the money is completely lost. If the well produces, the wildcatter stands to make a fortune.

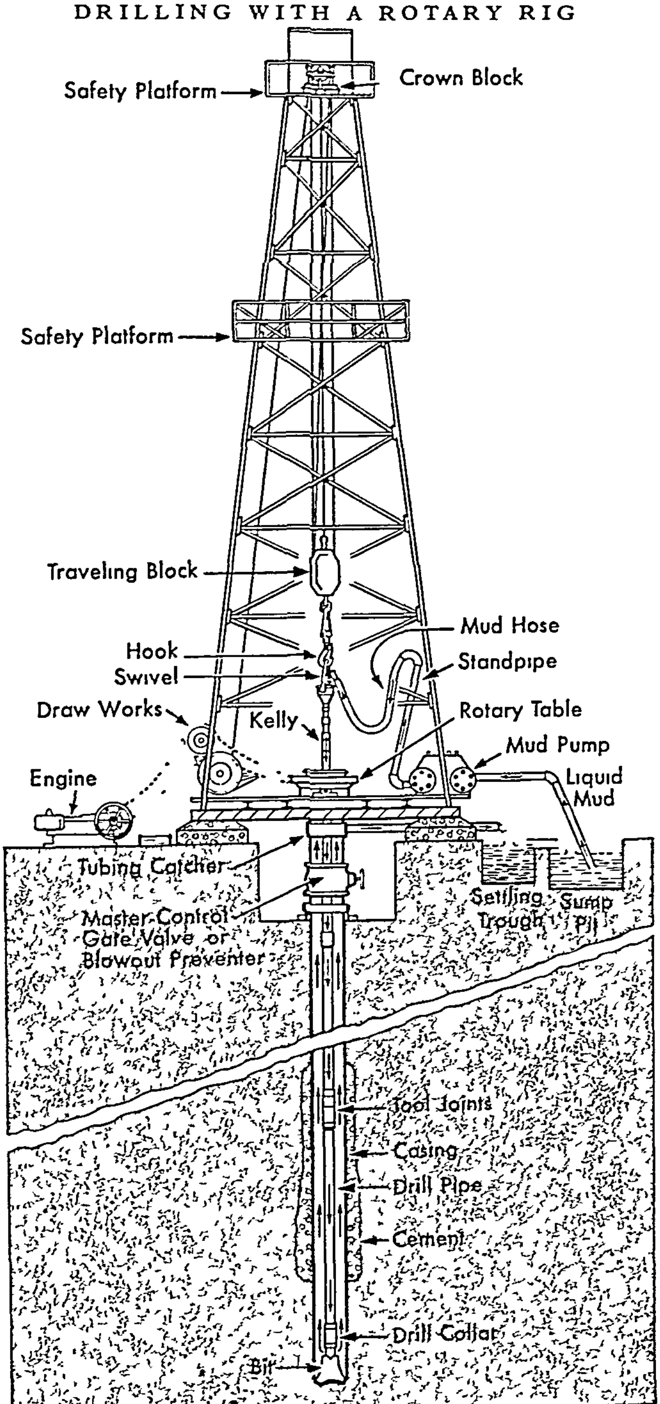
The driller has a choice between two kinds of drilling equipment. The older *cable tool drill* is made up mainly of a string of tool pipes, a bit, and a walking beam. The beam raises and lowers the bit at the end of the string of pipes, and the well is drilled by a kind of hammering action. The cable tool drill works best for drilling wells in hard rocky formations, where the oil lies at shallow depths. Cable tool drills were first used for digging brine wells.

The *rotary drill*, shown in the picture, is more commonly used. It bores into the rock like a huge carpenter's brace and bit. The drilling bit is attached to the end of a piece of steel drilling pipe. Lengths of pipe are added as the hole grows progressively deeper. The pipe and bit are turned by a powered *rotary table* on the floor of the derrick. The top of the pipe fits into the *kelly*, a heavy forging with square outside walls The kelly is held in the table by bushings that allow it to move up and down as necessary. Power from the engine, transmitted through a *draw works*, rotates the table and the kelly, which rotates the pipe and bit.

Aiding Drilling with Mud and Casing

As the bit drives into the hole, mud under tremendous pressure is pumped through the hollow kelly and drill pipes. It comes out through holes in the bit and is forced back to the surface. The mud carries with it the cuttings made by the bit. It also cools the bit and lines the drill hole with a mud cake. Finally the weight of the circulating mud curbs the tremendous gas pressures encountered in the hole. If unchecked, these gases might wreck the derrick. Sometimes the sides of the hole are soft or they contain much water. To prevent the hole from caving in, oilmen line, or "case," it with steel pipe. The casing is lowered into the well around the drilling pipe. Then liquid cement is poured around the outside of the casing. This fastens the casing firmly.

DRILLING WITH A ROTARY RIG



This diagram shows how a rotary drill works its way to oil-bearing sands. Drilling is performed by a bit at the end of a string of drill pipes. The bit and pipes are turned by the rotary table arrangement. Power is transmitted from the engine through the draw works. Mud forced through the drill pipes serves many purposes.

Problems in Drilling

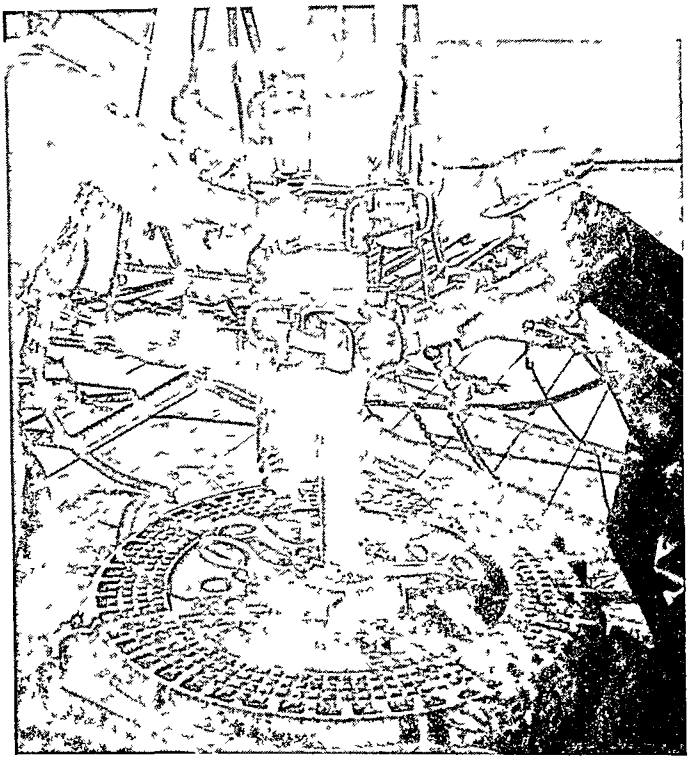
Drillers face many problems in keeping a well going straight down to the oil-bearing sands. Even in normal drilling, the clockwise rotation of the bit tends to change the direction of the hole. The various strata encountered will also cause deviation. Sometimes drillers intentionally turn the hole. They may want to bypass a difficult stratum or to get to a subsurface area under a road or even a city.

For whatever reason, the drillers must know what direction and angle the hole is taking. An older means for determining this was the acid bottle method. A bottle partly filled with acid was lowered to the turn. Here the bottle stayed until the tilted liquid etched a ring on the side, showing the angle of the turn.

A modern method uses a camera and a compass. A watertight container, holding batteries, a compass, a plumb bob, and a small camera, is lowered into the hole. The batteries provide power and light for photographing the face of the compass and the angle of the well wall at regular intervals.

If the survey shows a bad crook (*dogleg*) in the hole, the driller pulls out all the pipe and fills the hole with cement to a point above the dogleg. Then he resumes drilling through the cement. If the hole is only slightly crooked, the driller can use a whipstock to straighten it. This tool looks like a tapered chisel with a

ADDING MORE PIPE TO THE STRING



As drilling goes deeper, more lengths of pipe must be added to the string, as shown here. The large ring is the rotary table. The kelly is in the center.

collar at one end. The collar guides the whipstock down the drill pipe until the whipstock blade slips past the bit. There the blade deflects the bit toward the desired direction of drilling.

Logging the Well

The driller must record everything that happens during operations This record is the well's *log.* In the log, he notes especially the difficulties encountered and the various rock formations met. To learn the kinds of rock, he takes *core* samples. He drops a long slender *core barrel* inside the drill pipe. The core barrel has a sharp bit that locks inside the larger drill bit. As the bits rotate, a core of rock and soil forces its way into the barrel. The driller draws the barrel to the surface, empties it into a core tray, and sends it to a geology laboratory for analysis.

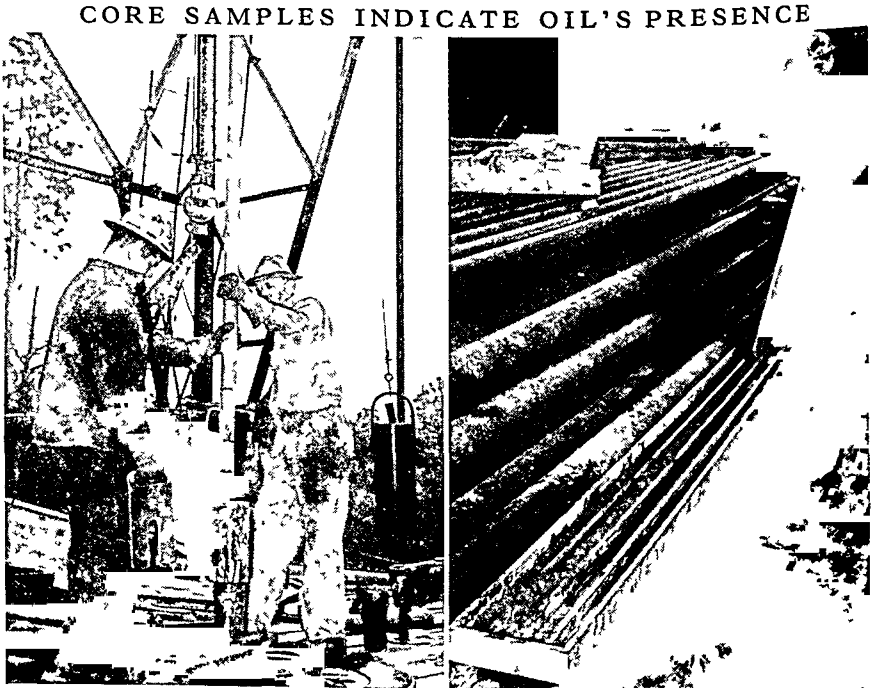
Electrical logging also tells the driller about rock formations. Long electrodes run into the hole reveal the nature of the formations by registering varying resistance to the passage of electric current. *Gamma ray* logging analyzes formations by measuring their radioactivity. Each kind of rock has a different degree of radioactivity. The measuring instrument is a Geiger-Muller counter lowered into the hole (*see* Radioactivity).

It's Oil!

Finally the driller decides he has reached the oil formation. With the casing set, he drills through the hardened cement at the bottom of the hole. The drilling stops and the driller runs in the *tubing,* a pipe about two and one half inches in diameter. It extends from the top to the bottom of the well The mud is then cleaned from the hole and the well permitted to start producing.

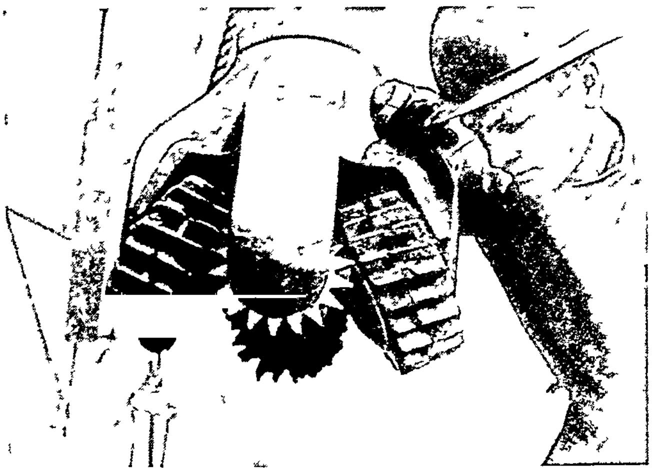
In the early days, many wells came in as gushers. They were permitted to flow over the top of the derrick until the well was thoroughly cleaned of mud. Today this terrible waste is prevented by an intricate system of valves and pipes fastened to the top of the casing at the ground surface. These valves and pipes, called a *Christmas tree,* control the flow of oil and natural gas. They can withstand thousands of pounds of pressure. Gas energy creates the pressure which moves oil through the subsurface formation to the well bore and up the hole. Today the amount of gas produced per barrel of oil is kept to a minimum to increase the

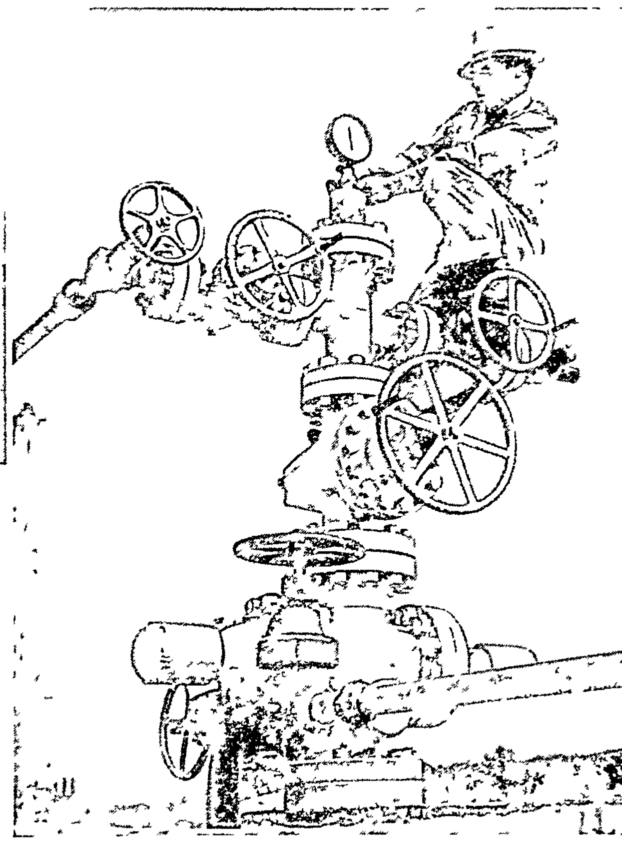
CORE SAMPLES INDICATE OIL'S PRESENCE



To learn the nature of rock formations reached by the drill, oil men take core samples for laboratory tests. At the left, they insert a core barrel into the drilling pipe. At the right, the sample is being emptied into a tray. Tests show if there is oil at the level where the sample was taken.

TWO IMPORTANT TOOLS IN PETROLEUM PRODUCTION





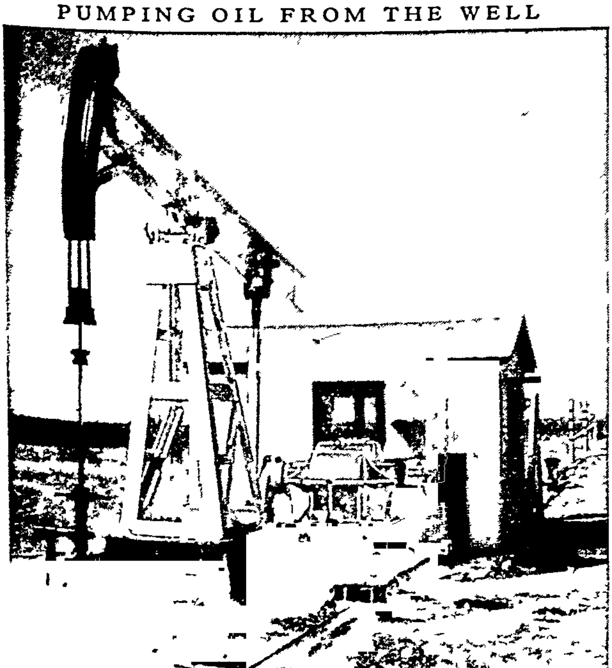
The rock bit (top) crunches and grinds through hard-rock strata as it rotates downward. The bit must be replaced periodically because the teeth wear down. At the right is a *Christmas tree.* It controls the flow pressure of oil and gas from the well.

recovery of oil. In contrast to earlier practices of allowing wells to flow "wide open," the amount of oil a well produces is now held to an efficient rate. In many states this rate is determined by state agencies.

Sometimes nitroglycerin is exploded at the bottom of the hole to crack or break the producing formation and allow additional gas and oil to enter the hole. Another method is to use acid to "eat" drainage channels into the producing formation. A newer technique applies chemicals under high pressure to crack the formation.

Oil engineers have learned how to repressure depleted sands with gas and how to inject water into the producing formation to force more oil into the hole. When gas energy declines to the point where it no longer pushes the oil to the surface, the wells are pumped. A walking beam moves a string of rods up and down in the hole to activate a pump submerged in the oil. All these methods help produce a maximum percentage of the oil held in the underground reservoir.

PUMPING OIL FROM THE WELL



When a well does not have enough natural-gas pressure to bring the oil to the surface, a pump like this one does the work.

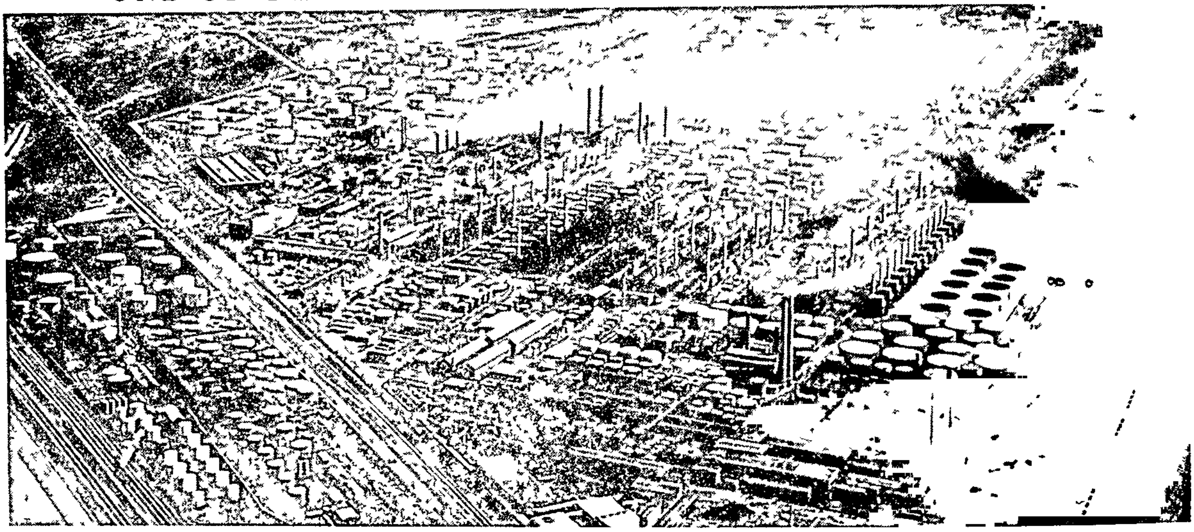
During each of two typical years in the 1950's, nearly 46,000 wells were drilled in the United States. These wells represented the drilling of more than 186 million feet of hole. About one third of the wells drilled were dry. Of the wildcat wells (those drilled in unproved territories) eight out of nine were dry. Modern drilling methods permit going down 15,000 feet in search of oil. One well, in Wyoming, is 20,520 feet deep.

Separating Crude Oil from Natural Gas

Crude oil goes directly from the well to an *oil and gas separator*. The gases and the water are removed, and the crude oil is stored in tanks. Here it awaits shipment to refineries by pipelines.

The gas removed from the crude oil is called *wet gas.* This substance yields several products. One is *natural gasoline,* which needs relatively little treatment before it is ready for final use. Another is *liquefied petroleum gas,* called LPG in the industry. Other industrial names for this product are either *butane* or *propane,* from the principal hydrocarbons present. At normal temperatures and atmospheric pressures, LPG exists as a gas. Under slight pressure it becomes a liquid and can be stored and shipped in metal "bottles." It is used in homes and as a motor fuel. *Natural gas* is another product of wet gas (*see* Gas, Natural).

ONE OF THE GREAT OIL REFINERIES OF THE WORLD



Here at Whiting, Ind., the ground is dotted with hundreds of storage tanks. They contain many different petroleum products. An intricate system of pipelines connects the various stills and tanks. This air view indicates the enormous amount of equipment that is necessary to supply automobiles, homes, and industries with fuel, lubricants and other petroleum products.

Refining Petroleum into Its Products

THE USUAL color of crude oil is black with a slight greenish cast. It has about the same consistency as table syrup. However, no matter what its color or consistency, petroleum consists mainly of complex molecules of two chemicals, hydrogen and carbon. Small amounts of other elements may be present as impurities.

The hydrogen-carbon molecules are called *hydrocarbons*. The number and arrangement of atoms in the molecules make up the different compounds, or *fractions*, of petroleum. Fractions in crude oil (or "crude") may be divided into *paraffin-base*, *asphalt-base*, and *mixed-base* crudes. These names come from the types of hydrocarbons present (*see* Hydrocarbons).

Each fraction has a different boiling point. This property makes it possible to separate the fractions by distillation. Further treatment yields the scores of products shown in the chart on the opposite page.

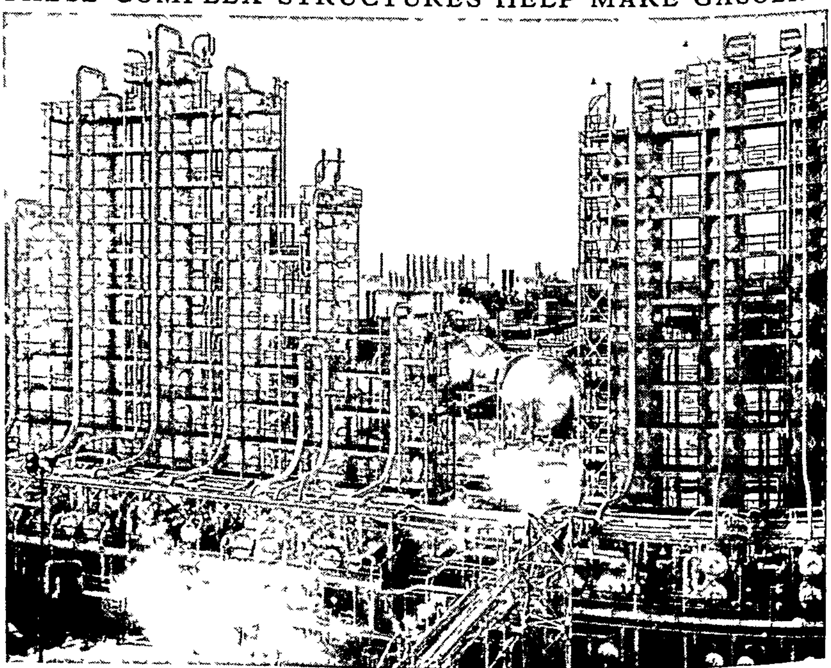
First the crude oil goes to a pipe still. There it is preheated to about 400° F. Then it passes to the fractionating, or "bubble," tower for the first major treatment, at temperatures as high as 750° F.

The Fractionating Tower

The tower is a tall cylindrical structure, varying in size according to the daily output of the whole refinery. A typical bubble tower is about 125 feet high and perhaps 25 feet in diameter. Inside the tower are horizontal trays spaced from bottom to top.

The crude oil from the pipe still is already partly vaporized. Huge furnaces at the base of the fractionating tower continue the vaporization. The vapors enter the tower and rise. The compounds with the highest boiling points condense first on the lowest trays. The vapors with lower boiling points rise until they lose enough heat to liquefy and collect on trays at higher levels. Some of them rise all the way to the top as gases.

THESE COMPLEX STRUCTURES HELP MAKE GASOLINE



This intricate maze of towers, tanks, and pipes is a fractionating unit at a Texas oil refinery. It takes the "light ends," or light petroleum fractions, from the bubble tower and transforms them into mixing stock for automobile or aviation gasoline.

PETROLEUM'S GREAT STORE OF USEFUL PRODUCTS

GASES

- **Hydrogen**
  - Metal Cutting, Glass Manufacturing Fuel, and Carbon Black
  - Cooking-Illuminating Gas
  - Synthetic Rubbers
  - Lube-Oil Additives
  - Aviation Gasoline Blending Agents
  - Antifreeze, Fat, Lacquer, and Drug Solvents
  - Inks, Paints

LIGHT OIL

- **Gasoline**
  - Gas-Machine Gasoline
  - Airplane Fuels
  - Automobile Fuels
  - Rubber and Fatty Oil Solvent, Lacquer Diluent
  - Explosives
  - Naphtha for Use by Varnish Makers, Painters, Dyers and Cleaners
    Naphthas and Turpentine Substitutes
- **Kerosene**
  - Stove, Lamp, and Tractor Fuels, Railroad Signals, Lighthouse Oil, Ship Illuminants, Gas Absorption Oils

MEDIUM OIL

- **Gas Oil**
  - Lube-Oil Additives, Paint Driers, Fungicides
  - Water Gas Carburetion Oils, Metallurgical Fuels, Heating Fuels, Diesel Fuels
- **Absorber Oil**
  - Gasoline Recovery Oils, Benzol Recovery Oils

HEAVY OIL

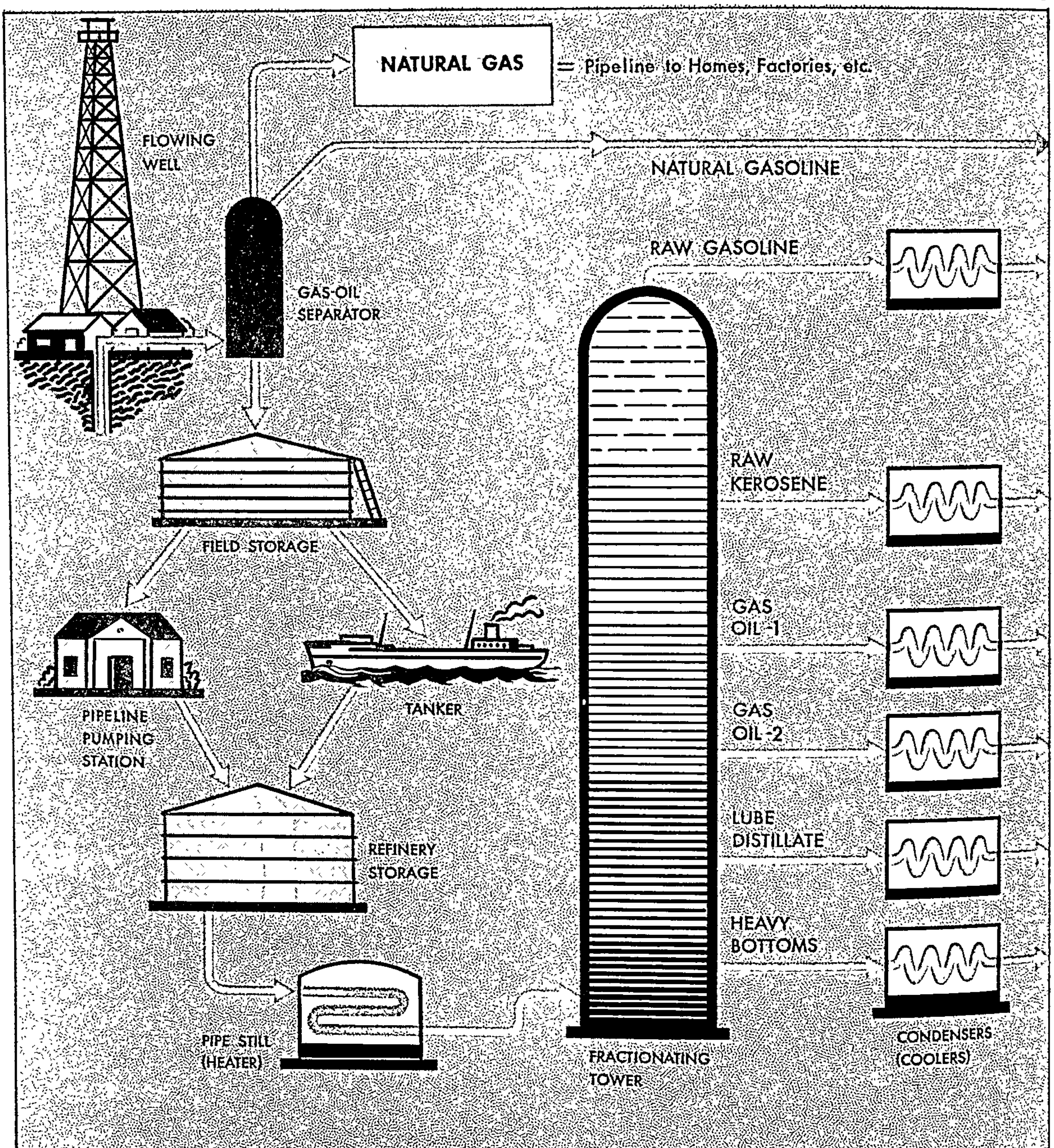
- **Lubricating Oils**
  - Insecticide Sprays, Tree Sprays, Bakers, Fruit Packers, Candymakers, Egg Packers, and Slab Oils, Recoil Oils, Hydraulic Oils
  - Internal Lubricants, Salves, Creams, and Ointments
  - Wool, Leather and Twine Oils, Coal Spray Oils, Dust-Laying Oils, Cutting, Textile, Paper, and Leather Oils, Metal Recovery Oils, Quenching Oils
  - Candymakers, Chewing Gum, Candle, Laundry, Sealing, Etchers, Saturating, Insulating, Match Cardboard, Paper, Medical and Canning Waxes
  - Lube-Oil Pour Depressant
  - Grease and Soap Lubricant
  - Rubber Compounding, Detergents, and Wetting Agents
  - Turbine, Light Spindle, Transformer, Household Lubricating, Compressor, Ice Machine, Meter, Dust and Tempering Oils
  - Journal, Motor, Diesel, Engine, Aircraft, and Railroad Oils
  - Steam Cylinder, Valve, Transmission, Printing, Black Oils and Lubricating Greases, Tempering Oils
- **Lubricating Oil Residuum**
  - Salves, Creams, Ointments, and Petroleum Jelly
  - Rust-Preventing Compounds, Rubber Softeners, Lubricants, and Cable-Coating Compounds

RESIDUES

- **Residual Fuel Oils**
  - Wood Preservative, Boiler Fuel, Gas-Manufacture Oils and Metallurgical Oils
- **Asphalts**
  - Roofing and Shoe Material, Shingle Saturants, Roofing Saturants, Road Oils, and Emulsion Bases
  - Briquetting and Paving Asphalts, Paint Bases, Flooring Saturants
  - Roof Coatings, Waterproofing, Rubber Substitutes, and Insulating Asphalts
- **Coke**
  - Carbon Electrodes, Carbon Brush, Fuel Coke, Metallurgical Coke
- **Refinery Sludges**
  - Fuel
  - Saponification Agents, Fat-Splitting Agents, Special Oils, Demulsifying Agents, Emulsifiers
  - Refinery Fuel

This chart suggests the wealth of products derived from petroleum. The left-hand column shows fractions of crude petroleum. Next come the intermediate stages in treatment. The "hydrogen" at the top indicates the addition of this element to the other gases. The most important final products are shown in the blue panels. But no table could show them all.

HOW CRUDE OIL IS CHANGED INTO



The flow lines (arrows) indicate the steps in transforming crude oil from the well (upper left) to the finished products, shown in blue panels. Blue flow lines show petroleum which has had little or no treatment; orange lines indicate flow through treatment processes. Natural gas passes off from the well and from the first separating step at the top. Some of the important fractions are passing from the fractionating (bubble) tower. Other fractions, such as hydrogen and naphtha, are not shown.

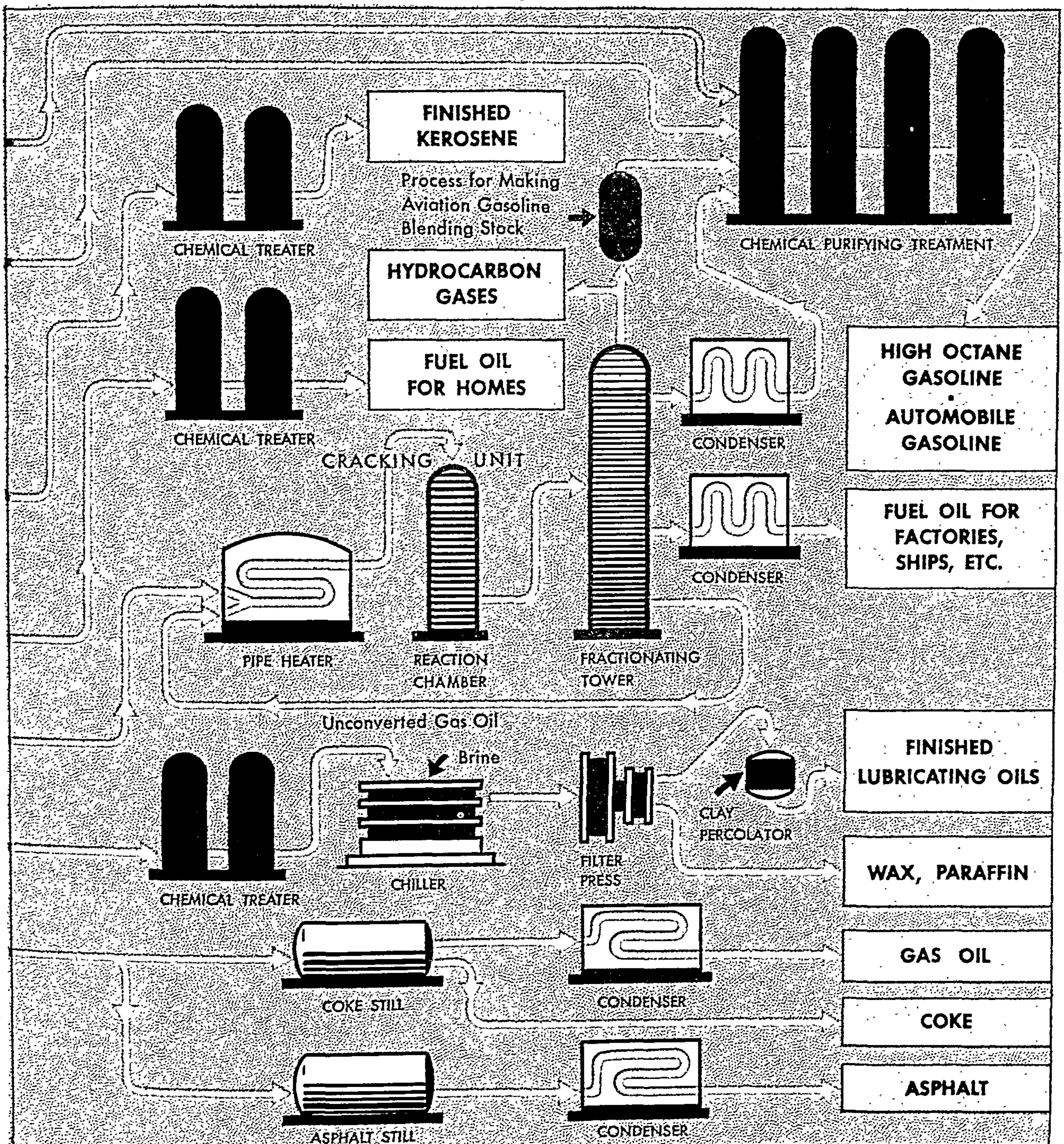
The trays fill until they overflow, and the liquid passes through a downpipe to the tray below. There it is reheated by rising vapors, and more volatile portions are revaporized and rise again. The process of condensation and vaporization takes place over and over again. With each repetition the fraction on the tray becomes more pure.

At certain trays the condensed fractions are drawn out of the tower through pipes, called *side-draws*. The products are sometimes called *cuts*. The chart above shows some of the different cuts that are being drawn off from the bubble tower. The cuts go to condensing units where they are cooled and made ready for further treatment.

Cracking Petroleum Cuts into Gasoline

Of all the products of petroleum, gasoline is the best known and the most in demand (*see* Gasoline). Separation of raw, or straight-run, gasoline in the bubble tower does not yield nearly enough to satisfy the rising demand. As early as 1910 chemists

VALUABLE PETROLEUM PRODUCTS



The diagram shows the second fraction of gas oil passing to the cracking unit, but almost any fraction may be cracked. The cracking unit may be of the thermal or the catalytic type. The panels at the lower right indicate some of the important products obtained from the heavier elements of petroleum. The clay percolator at the end of the lubricating oil flow dewaxes the oil. This diagram shows only the main steps in treatment. Actual processing is too complex to be shown in a simple diagram.

were working on a method of breaking up, or *cracking*, the large molecules of gas oil to form the lighter and smaller molecules of gasoline. In 1913 the first commercially successful cracking process was introduced by Dr. W. M. Burton and his associates.

The chemists found that if they applied temperatures from 800° F. to 1,200° F. and pressures of 350 to 1,000 pounds to the square inch, the larger molecules would break down. The method was named *thermal* cracking. Improvements in thermal cracking nearly tripled the yield of gasoline from various fractions, permitting the extraction of nearly 50 per cent gasoline from a barrel of crude oil. Controlled thermal cracking can also produce many final petroleum products.

The high pressures and temperatures of thermal cracking are somewhat injurious to the delicate hydrocarbons of gasoline. Today thermal cracking is largely replaced with *catalytic* cracking (sometimes shortened to "cat" cracking). In chemistry a catalyst

is a substance which helps a chemical reaction take place while remaining unchanged itself. The catalyst used in the process is either an aluminum or silica clay, a synthetic claylike material, or platinum.

Credit for developing the original catalytic cracking process belongs largely to Eugene Houdry, a French engineer. He began experiments in about 1922, and by 1936 his process was producing gasoline on a commercial scale. The Houdry catalytic cracking process begins with drawing off gas oil from the bubble tower. It passes to a reaction chamber where it meets the catalyst. When the catalyst becomes covered with carbon, the flow of gas oil is switched to another chamber while the carbon is burned off. This is sometimes called a *fixed-bed* process, because the catalyst is held in stationary trays.

To keep reaction chambers in constant use, scientists have devised *moving-bed* processes. In the *thermofor* method, the catalyst is in the form of small pellets or beads. Oil vapor rises against a moving stream of pellets. At the bottom of the chamber, the catalyst is removed and cleaned.

The *fluid* method, introduced in 1942, uses a powdered catalyst, slightly coarser than talcum powder. It is blown into the vaporized gas oil and comes in contact with nearly every particle of the stream. The catalyst is removed from the treated vapor in a separator and is cleaned for further use. The flow of catalyst through the vapor and cleaner, aided by blowers, is continuous.

Special Refinery Processes

Some of the hydrocarbons of crude oil cannot be converted to gasoline because they do not have hydrogen enough in proportion to their carbon content. Refineries now reclaim various hydrocarbon oils by adding extra hydrogen under high pressures and temperatures, with a catalyst present. This process is called *hydrogenation.*

At one time, some very light hydrocarbon molecules were lost in the refining process because they escaped as gas. A process, called *polymerization*, converts these lighter molecules to heavy ones, suitable for blending into gasoline. The process may use either thermal or catalytic methods. Another process of combining hydrocarbons is called *alkylation.* It combines lighter molecules into heavier ones, using sulfuric or hydrofluoric acid as a catalyst. *Isomerization* rearranges the carbon and hydrogen atoms into molecules more suited for use in making gasoline.

Transportation in the Oil Industry

Many oil-producing regions are remote from centers of population. One of the best ways of transporting the oil to refineries is through pipelines. Some of these are very long. The pipeline from Kirkuk in Iraq carries oil 1,165 miles across burning deserts to terminals on the Mediterranean Sea. In Russia, pipeline systems of comparable length carry oil from the shores of the Caspian Sea to industrial centers to the west and north.

The United States has a network of some 150,000 miles of crude oil and product pipelines. Among them are individual lines from 1,000 to about 2,000 miles long. These pipelines link the important producing regions of the South and West with the refineries of the Middle West and the East. The original Standard Oil Company owed its power largely to control of pipelines, but these are now common carriers, available to any producer. From the refineries a system of pipelines built on a much smaller scale carries gasoline and other products to important distributing and consuming centers.

Pipelines usually are made of steel, and they range from 4 to 30 inches in diameter. Pumps at intervals of 40 to 200 miles force oil through them. Reserve supplies are held on tank farms until needed. Different batches of oil or gasoline can be sent through the lines one behind the other without mixing with each other. To keep the lines from clogging, they are regularly bored out with a rotating circular scraper called a *go-devil.* It is forced through the pipe by the flow of the oil.

Other carriers are railway tank cars and motor tank trucks. The tank cars carry some of the crude oil to refineries. The tank trucks usually carry gasoline and other products from the refineries and bulk stations to service stations, garages, and other retail outlets. They also carry fuel oil to homes. Oil is carried across the seas in large ships called tankers. A huge fleet is employed both in world trade and to carry oil from California, Texas, and Louisiana to refineries on the Atlantic coast.

Petroleum—a Giant among Industries

THE PETROLEUM industry in the United States leads all other mineral industries in the value of its products. In wealth of assets, it is the second richest of all industries in the nation. The capital worth of the industry has been estimated at about 30 billion dollars. It produces and refines about $2\frac{1}{3}$ billion barrels of petroleum products yearly. The average cost of crude oil is about $2.50 a barrel, but this figure often fluctuates. (Production of crude oil in such leading petroleum states as Texas, California, Oklahoma, and Louisiana are given in the minerals tables in the Fact Summaries for those states.)

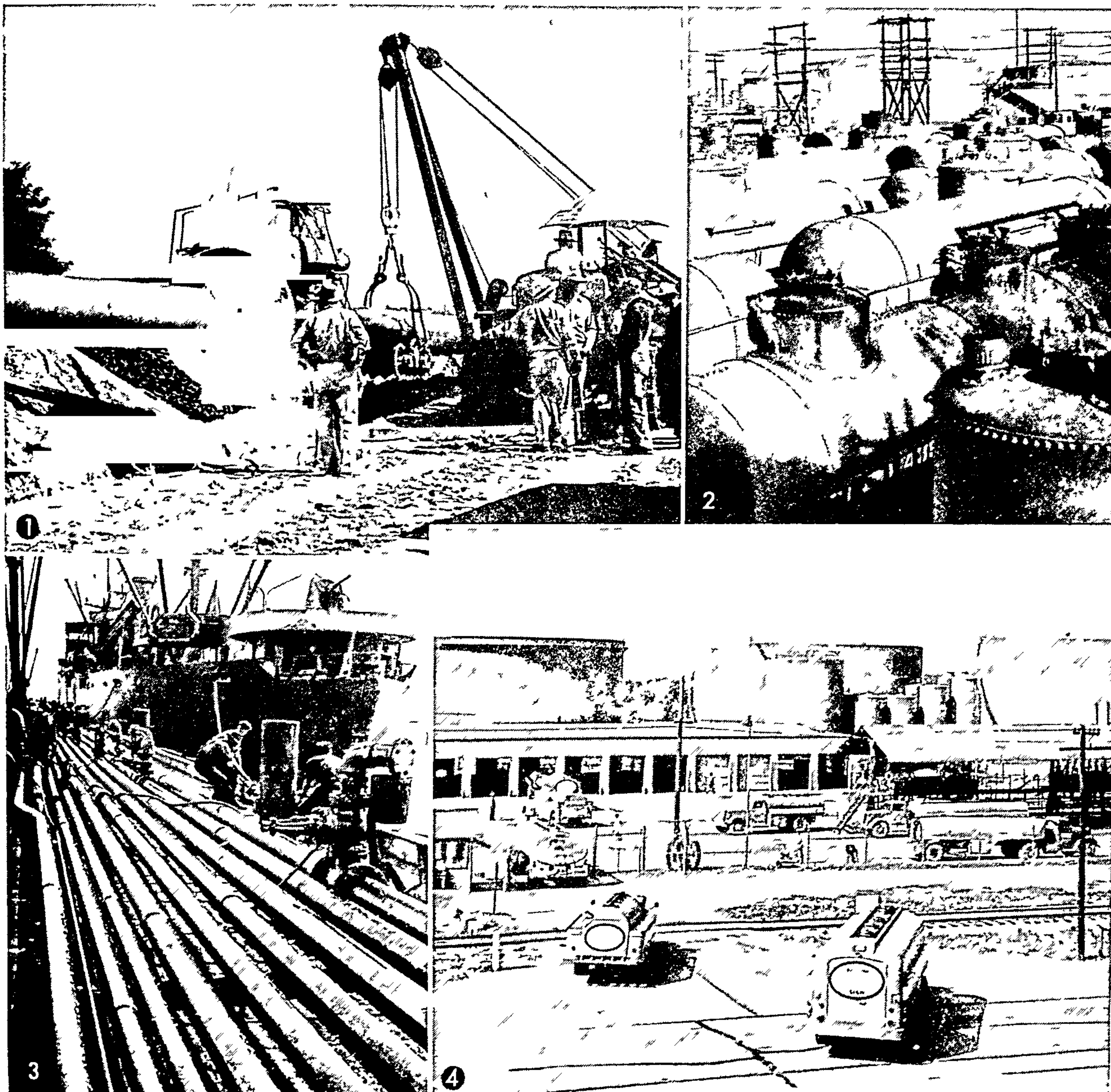
This vast industry was built in modern times. The groundwork was laid in the 1850's by the demand for kerosene as a lighting fuel to replace whale oil and coal oil. Swift growth came in the 20th century to serve automobiles, airplanes, locomotives, oil burners for heating and to supply lubricants and various products developed by petroleum chemistry.

Beginnings of the Industry

Even before the days of the Romans, men knew about petroleum. The Egyptians used heavy oil or asphalt for embalming and papermaking. In the fields of Baku on the Caspian Sea, the natives feared the "everlasting fire set by angry gods." These were oil and gas seeps, probably ignited by lightning.

When the first settlers came to America they found the Indians using petroleum as a medicine. Soon the colonists too were skimming the oil film from springs

MANY KINDS OF CARRIERS ARE USED TO MOVE OIL



1. This 24-inch pipeline is shown during construction. Today it is in service between Longview, Tex., and Norris City, Ill., a distance of 531 miles. The pipeline carries either crude or heating oil. 2. These tank cars are standing in front of a Texas refinery, waiting to be filled with various refinery products. 3. For overseas shipments, petroleum is carried in huge tankers. At Seattle, this cargo ship is taking on fuel oil from pipes along the dock. 4. Distribution centers like this one supply petroleum products to tank trucks. The trucks carry them to homes, service stations, and industrial users. Other trucks carry LPG bottles.

and creeks. They boiled the oil to purify it and used it as a cure-all under the name of Seneca Oil.

In the early 19th century whale oil was still the main oil for illumination. Petroleum was only a nuisance that spoiled salt wells. It was sold in small quantities as a patent medicine. As a fuel for lamps, it smoked and had a bad odor. Experiments in distilling the crude oil gradually resulted in kerosene. Some of these experiments were conducted by Samuel Kier, a Pittsburgh druggist, in the 1840's. Others were made by James Young, of Glasgow, Scotland, who distilled both lubricating and illuminating oils in 1847.

A New York lawyer, George H. Bissell, formed the first oil company in the United States in 1854. This was the Pennsylvania Rock Oil Company. But the company was dissolved before any wells were drilled. Bissell and his associates then organized the Seneca Oil Company. They leased land along Oil Creek, near Titusville, Pa. To supervise drilling they engaged Edwin L. Drake, a former railroad conductor. Drake hired "Uncle Billy" Smith and his two sons to do the work. These men were experienced brine-well drillers.

The usual method was to dig a pit down to the rock bed, then pierce the rock with drilling tools pumped up and down by a spring pole. However, in drilling for oil, all of Smith's pits caved in. Drake solved the difficulty by driving a large pipe through the earth to line the pit. A steam engine pushed the pipe into

the ground. On Aug. 28, 1859, they struck oil at a depth of 69½ feet. A great industry was started, and it owed much to Drake. He not only drilled the first well, he also introduced mechanical methods and the use of pipe to prevent cave-ins.

Boom Towns and Sudden Wealth

When Drake drilled his discovery well, Oil City, a few miles from Titusville, was a sleepy village. Within three months, 10,000 people had jammed into the town. They lived in shanties, tents, and even wagons. In two years the town had 50,000 inhabitants. Ten years later, when the oil was gone, the town was desolated.

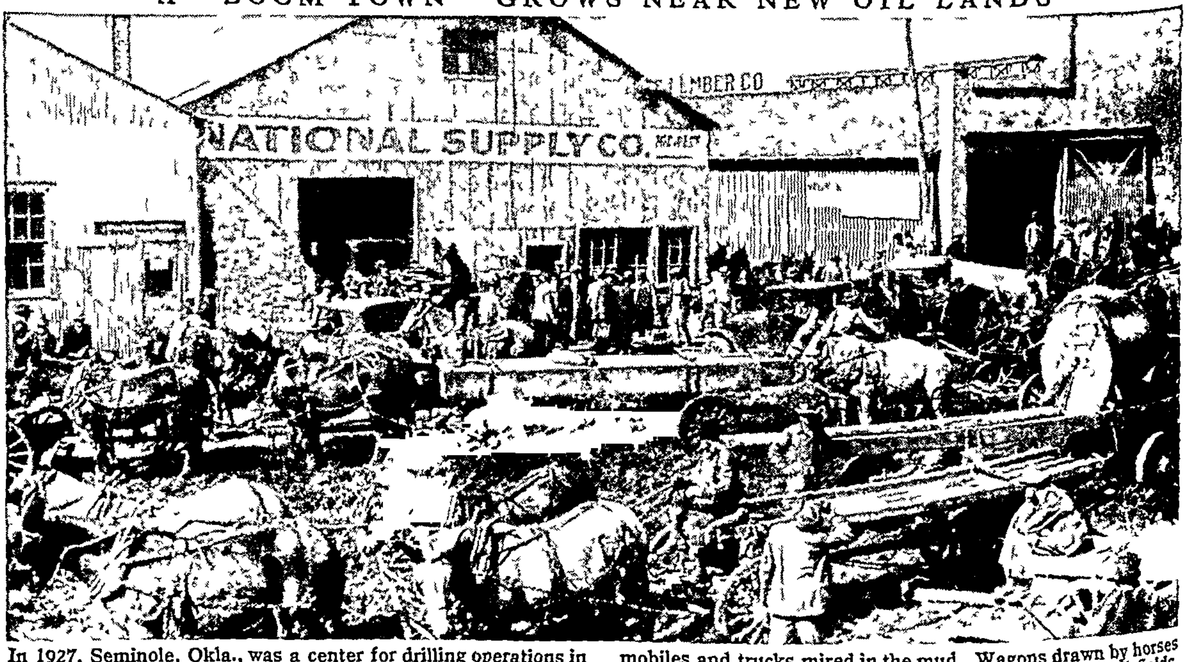
By the end of the first World War "boom" towns mushroomed over oil-producing areas in California, Illinois, Indiana, Kentucky, Kansas, Texas, and Oklahoma. Farmers and ranchers, scraping a meager living from poor lands, leased their holdings to promoters for a percentage. If oil was found, they became wealthy almost overnight. Typical of the era was the discovery of the fabulous Lucas gusher at Spindletop Knoll, near Beaumont, Tex. Drillers struck oil in a salt dome trap in 1901, and for nine days the well ran wild. An estimated million barrels of oil came up in that time. Soon more than 500 wells were drilled in the surrounding area. Three of the nation's largest oil companies had their beginnings here.

AMERICA'S PIONEER OIL WELL

Here was the first oil well in the United States, dug near Titusville, Pa., in 1859. The chief driller was "Uncle Billy" Smith (left). The director of the company was E. L. Drake (right).

Within the next 50 years, rich producing fields were found over the Southwest. Stories of discoveries and the gaudy, reckless boom towns of this era are an exciting part of American history. One of the greatest producing fields in the United States was ushered in quietly in 1930. After three years of prospecting around Kilgore, Tex., C. M. Joiner struck oil. His discovery well was comparatively small. But those that followed came in at about 15,000 barrels a day with startling regularity. Today this great eastern Texas field averages 150 million barrels yearly and helps Texas maintain its rank as leader of the oil-producing states.

A "BOOM TOWN" GROWS NEAR NEW OIL LANDS



In 1927, Seminole, Okla., was a center for drilling operations in the surrounding territory. The streets were unpaved and automobiles and trucks mired in the mud. Wagons drawn by horses and mules were used to transport equipment to the oil fields.

In the early 1950's a new boom took place in the huge Williston basin that sprawls across North Dakota and extends into South Dakota, Montana, Saskatchewan, and Manitoba. Enough oil was found to indicate that this region would be tremendously productive for years to come (*see* North Dakota).

Oil from the Mountains and under the Sea

A vast untapped supply of petroleum lies in the shale and marl mountains of Colorado, Utah, Wyoming, and nearby states. A solid substance called *kerogen* was formed ages ago in these sedimentary rocks. When shale or marl "ore" is heated in a retort, the kerogen gives up a liquid hydrocarbon resembling crude oil. When refined it yields several valuable petroleum products. A ton of shale or marl contains enough kerogen for five to eighty gallons of refined products.

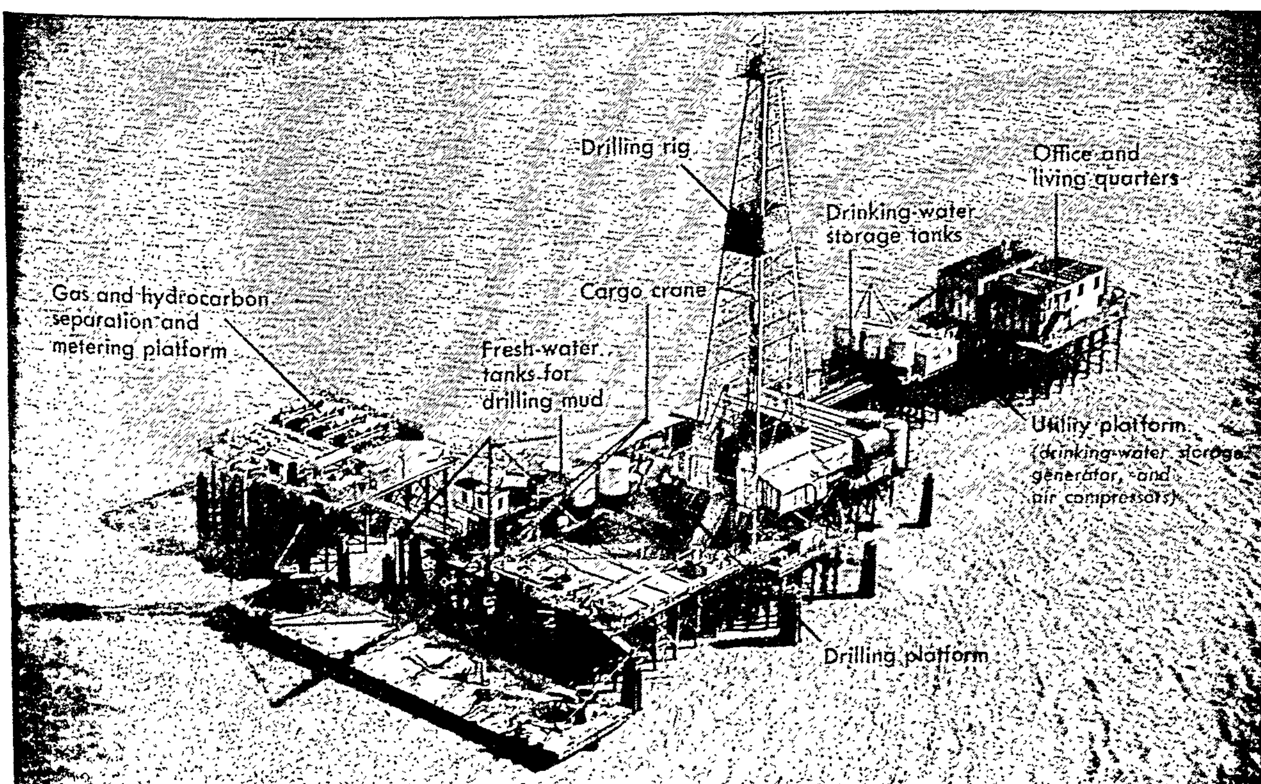
Both the mining and the treatment of shale and marl require processes different from those used in handling petroleum from underground sources. In 1944 Congress passed the Synthetic Liquid Fuels Act to provide funds for research and pilot plants. Under this act private oil companies co-operate with the Bureau of Mines. Despite many unsolved problems the United States looks to its shale and marl mountains to supplement its petroleum supply.

The land masses of the continents actually extend miles beyond their shore lines, forming an underwater *continental shelf* (*see* Earth). These areas are popularly called *tidelands*, although the term correctly used means only land covered by flood tide and exposed by low tide. Another term is the *offshore area.*

Off California and the Gulf coast states, the continental shelf is rich in petroleum. Little is known of its geographical formation and extent, and accurate estimates of reserves cannot be made. However, oil men are confident that the continental shelf off these states will sustain petroleum production for years after other sources are exhausted.

Development of the shelf has been hampered by the enormous cost of exploratory drilling. Disputes between the states and the federal government over the inner portion of the shelf have also slowed development. In these disputes, California claimed that its historical boundary extended 3 miles into the Pacific Ocean. Texas and Florida claimed their boundaries have always been $10\frac{1}{2}$ miles into the Gulf of Mexico. Louisiana asserted its boundary to be 3 miles into the Gulf. The states therefore claimed control of oil found within these boundaries.

Congressional bills to establish state control of these areas were vetoed by President Harry S. Truman in 1946 and 1952. In 1947 and 1950 the United States Supreme Court affirmed the federal government's "paramount rights" to the submerged lands. However, in 1953 Congress passed a bill that gave the sought-after titles to the states involved. The same bill retained federal ownership of lands beyond the historical state boundaries.



UNDERWATER DRILLING PLATFORM

Five successful natural-gas wells have been drilled from this platform in the Gulf of Mexico, 17 miles offshore from the Louisiana mainland. Gas and liquids are delivered to the mainland by an underwater pipeline. The water here is about 12 feet deep.

PETS—

And How to Care for Them

TWO TRUSTING FRIENDS
Kitty's ears prick up as it listens closely to its young master's whisper. Many cats become loving family pets.

DUCKLINGS ARE POPULAR PETS
This proud young man is holding his baby duck correctly, cupped in his hands. He holds it firmly but does not squeeze it.

PETS. You like pets, don't you? So do we. Everyone likes some animal, from dogs and cats to parakeets and woodchucks. Treat them well and they will think you a wise, kind master and friend. You will learn a great deal from them too.

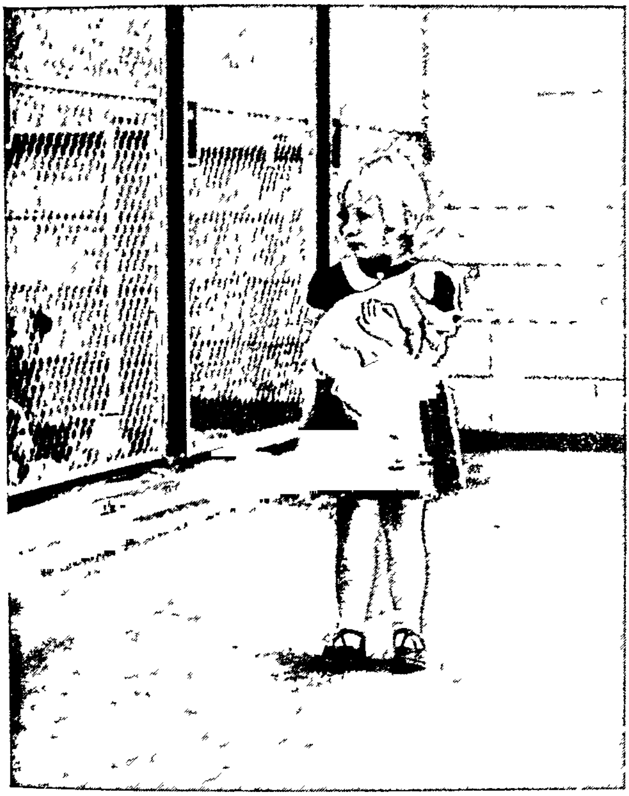
When we were growing up we had pets all around us. They lived in our house, in our yard, the sandbox, and the pigeon roost. We seemed to get a new kind of pet every year. That meant learning how to care for another young animal. The only people who deserve pets are those who take good care of them.

A pet is not just a plaything you can neglect when you are tired or when you go on vacation. Like you, a pet has to have food, water, shelter, kindness, and fun—and your pet depends on you for all that. Before you buy or accept any pet, young or old, be sure you can take good care of it. That is only fair.

What You Should Know about Any Pet

Here are the chief rules to follow in caring for any pet: (1) know what to feed it and when to feed it, and feed it regularly; (2) be sure that fresh water is always within its reach; (3) keep its living quarters clean. Chill, dampness, overfeeding, and uncleanness are common causes of pet sickness. No animal, not even a pig, likes to be dirty. If your pet gets sick, you will be wise to take it to a doctor. Animal doctors are called veterinarians.

Even little children must learn to treat pets gently. They are easily frightened. Jerky movements or a sudden shout may startle them. Even the



PUPPIES AND RABBITS ARE FAVORITES WITH CHILDREN

She has chosen a puppy at an Anti-Cruelty Society shelter. See how she holds it, one hand supporting its little haunches.

Raw carrots help a rabbit's teeth. The bunny's size shows the care its young owner gave it as a baby rabbit.

tamest may nip or scratch in frightened self-defense.

When you first bring your pet home put it in the shelter you have provided for it and give it fresh water. Talk gently to it for a few minutes, without touching it, then let it alone for a while to get used to its surroundings. If it is a dog or cat or other mammal, you can probably get acquainted with it as soon as it has rested and feels safe in its new home. Talking easily, slowly lower your hand and let it sniff your fingers to get used to your human smell.

You can then probably stroke it to give it confidence in you and let it know that you like it. With the exception of dogs and cats, pets should be handled only when necessary or when they invite petting.

Familiar Friends—Dogs, Cats, Rabbits, Ducks

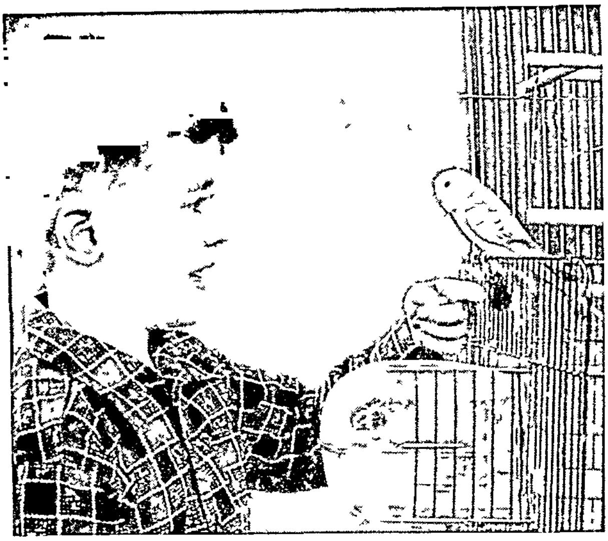
Even in prehistoric days people had pets. The first was the dog, which man started to tame in the Stone Age. The cat has been a pet since the days of ancient Egypt. Today, in both the city and on the farm, dogs and cats are still the most popular pets.

In the article on Dogs you will see natural-color photographs of various breeds of dogs and a table of American Kennel Club Breeds and Standards. The article tells you how to select your dog and how to feed it, care for it, and train it (*see* Dogs). The article on Cat shows you natural-color photographs of the officially recognized cat breeds. It also tells how to feed and care for a cat (*see* Cat).

Rabbits "hop through" the folklore of nearly every country. In our own land generations of children have laughed with Peter Rabbit, Molly Cottontail, and Brer Rabbit. A rabbit is an amusing pet and can be trained to do simple tricks. When you pick it up, do not lift it by the ears—they are very sensitive. Lift it by grasping the loose fold of skin on the neck and put one hand under its haunches to support it. Handle a baby bunny very little; then, with good care, it will grow into a sturdy pettable pet.

If you keep your rabbit indoors, cut a door in a grocery box for its house. Put shavings on the floor and change the soiled ones every day. You can housebreak a rabbit by always putting papers in the same place, near its nest. Do the same as you would for a dog or cat. The bunny will make a mistake now and then, so be patient. For living outdoors, the hutch for one rabbit should be at least three feet long and a foot and a half wide and high. Partition a sleeping place in one end. Set the hutch on posts. Cover all the floor with shavings, sawdust, or hay and keep it dry. Scrub the hutch once a week. Your pet should have an outdoor run enclosed by fine-meshed wire netting set at least two feet into the ground to prevent burrowing. In summer, shade the hutch.

Rabbits eat no meat. They eat hay, clover, oats, and bran; green foods such as grass, cabbage, and roots; and especially carrots. Lettuce tends to cause diarrhea. The oats and bran should be dampened but not soggy. Fasten the water container to the box or hutch so it will not spill. If your rabbit shows even a trace of diarrhea, give fewer green vegetables. Too much cabbage at any time gives the bunny an




A TRAINED PARAKEET AND A TAME YOUNG ROBIN

Pat, the parakeet, will hop on the boy's finger in a second for a ride around the room. Notice how long a parakeet's tail is.

Chippy, blown from its nest, now lives wth a neighborhood family. Young wild birds can often be trained as pets.

unpleasant odor. Pet stores sell rabbit food in the handy form of pellets. The best of them contain hay and necessary minerals and grains. With the pellets, your pet would enjoy a carrot a day. Try also to give it a thick twig or something else to gnaw on, because its teeth, like those of all rodents, are always growing. (*See also* Rabbits and Hares.)

Every Easter thousands of children get baby ducks. Nearly everyone wants to pick up a fluffy little duckling, but you should not handle it much until it is about half grown. Let your baby duck rest in its box, keeping it warm and out of drafts for two or three weeks. Cover the bottom with shavings, sawdust, peat moss, or shredded paper, and keep them fresh. A duck can rarely, if ever, be housebroken. Pet stores sell duck food pellets, and your duck also likes fresh green vegetables. Keep fresh water in the box.

After several weeks your duck will want to take to water. If you live in the city and cannot have a little pond in the back yard, give your pet an occasional swim in a washtub or spray it frequently with lukewarm water. Ducks are good companions and can be taught to do tricks. (*See also* Duck.)

The Gentle Clowns—Guinea Pigs and Hamsters

The tubby little guinea pig is a favorite pet, especially fine for the small child or shut-in. When you buy one from six to eight weeks old it easily becomes a part of the family. It loves to be held, petted, and to have its coat brushed smooth and clean. When lifting your pet, do not pick it up by the neck. Scoop it up gently. Even when hugged a little too hard a guinea pig will rarely, if ever, bite. Instead, it makes a deep rolling noise and grinds its teeth to tell you that you are hurting it. It quickly learns to know you as master, whistles for attention, and grunts softly and contentedly.

For food it can have rabbit food pellets, bread, rolled oats, fruits, and fresh greens, but not too much cabbage. A carrot a day helps keep its gnawing teeth from growing too long. Keep fresh water and rock salt handy. Change the sawdust or straw on the floor two or three times weekly and scrub the box twice a week to prevent odors from forming. If you go away, your pet can get along for three or four days if you leave food and water. (*See also* Guinea Pig.)

Hamsters are happy little pets. They love to play and be cuddled. Indeed, they like to be petted too much for their own good. Do not let it romp till it is tired out. Get a hamster about two months old. It soon learns to know you and can be taught tricks. With gentle handling, it is a fine pet for shut-ins, as it is clean, odorless, and friendly. The name "hamster" comes from the German word *hamstern*, "to hoard." You will know why when you see your pet stuff its cheek pouches with food and scoot away to hide it. (For the care of hamsters, *see* Hamster.)

Introducing Cage Birds

Parakeets, canaries, and other cage birds make delightful pets. They brighten any home with their jaunty whistles, trilling songs, or perky talk. They can be trained to come out of their cages and flit around the room, and many can learn to do tricks.

There are differences in the care and training of the various cage birds. When you buy your bird you can get a book or pamphlet telling about its special needs. Here, however, are a few general rules for the care of all cage birds. The cage should be large enough to let your bird exercise. Put the cage in a light place but not in a window or in a draft.

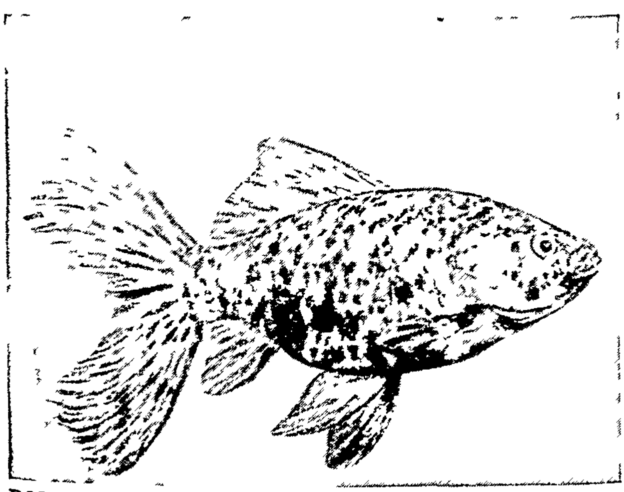
The room should not be too hot, as the bird will molt (lose its feathers) out of season—for a grown bird, the regular molting season is summer. Perches should be made of hardwood and, to rest the bird's feet, of different sizes. To clean the perches, use a perch scraper or sandpaper—do not wash them, as dampness can make your bird sick.

As birds have no teeth, you must supply cage birds with material for grinding their food. Depending upon the bird, give it gravel, grit, or cuttlebone. Give it fresh water daily and wash the drinking cup thoroughly every day. Most birds enjoy fresh greens, which should be washed to remove insecticides. Many people do not give them lettuce, as it tends to cause diarrhea. Above all, do not overfeed your bird.

Parakeets, or Budgies

Few pets became popular as quickly as parakeets, also called budgies. The beautifully colored little bird is a fine pet for shut-ins and people who live in apartments. With patience, you can teach almost any parakeet to talk. Its friendliness and playfulness make it a lively companion. Usually a young parakeet is easier to train than a mature bird. Some people prefer to get one from six to eight weeks old. Others take a bird up to three months or older.

When you bring your budgie home, let it stay in its cage from one to two weeks—until you see that it is used to its new surroundings and to you. The cage that best shelters a budgie is oblong—about 2 feet long, 18 inches high, and one foot wide. The cage wires should be strong and rustproof.



POPULAR FANCY GOLDFISH
This is a shubunkin goldfish. The type was first bred in Japan in 1900 The name means "bright red spotted with varied hues."

PREPARING FOR COMMUNITY PET SHOW
The boy is polishing his turtle's shell with vegetable oil. He will exhibit it at one of the many pet shows held in the nation.

At first your pet may not be able to find the food cup. Spread seed liberally among the gravel on the floor of the cage. Feed your budgie once a day. When it learns to eat from the cup, empty the waste hulls daily. Be sure it has grit. It also likes little extras in its treat cup, such as millet seed, a bit of green or apple, or finely chopped egg.

Wild budgies bathe in dew-wet grass. For the cage budgie, put less than an inch of water in a bird bath dish. You may have to lure the bird by floating a piece of green on the water or you may have to sprinkle it with lukewarm water.

When a budgie becomes tame in its cage you can finger train it. You may start by talking quietly to it as you slowly and repeatedly put your hand in its cage, near the bottom. It will come to sit on your finger. Then you can train it to stay on a play pen, a wood tray with sides raised to keep gravel from spilling. You can fit it with a variety of toys, such as bells, ladders, seesaw, and trapeze.

Do not let very small children handle your bird. Children of six years and more can learn to give it good care and can even help in training the budgie.

To teach your bird to talk, begin training it as soon as it is cage-tame. A budgie learns faster when it is the only bird. Some people cover the cage while they speak to the bird so it will concentrate on the voice. A budgie seems to find words starting with "p" and "b" the easiest to learn. Stand at the cage and, in your normal tone, say *clearly* a simple phrase such as "pretty Bill." Repeat several times a day, if possible, or at least five minutes each morning and night. Only when your pet has learned that one phrase should you teach it another.

Some budgies talk after two months of training. Others may take six months. Many people use parakeet recordings for teaching. Others prefer to train by their own voices, for the bird imitates the tone of its trainer. Some of them learn hundreds of words.

The budgie, or shell parakeet, is a native of Australia. It is also called "budgerigar" and "budgereegah," from the Australian bush word *budgeree,* meaning "good" or "pretty." Sometimes budgies are called love birds, but that name really applies only to tiny African parrots. Budgies are related to parrots and belong to the order *Psittaciformes.*

Parrots, Cockatoos, and Canaries

Parrots were the first talking birds to become popular. Voice training methods are the same as those for budgies. A gently handled parrot can become a clever and affectionate companion, but one that is teased will quickly inflict a nasty bite.

A parrot's cage preferably should be oblong, at least two feet high, with a flat top. Give your pet a bell, strong toys to pull apart, and a piece of wood to tear in pieces. Parrots are fruit eaters, but the

cage parrot may be fed a mixture of hemp, sunflower seeds, unhulled rice, and cracked corn. Occasionally feed it ripe fruit. Give it water two or three times a day, removing the cup each time because Polly delights to splash.

A cockatoo is a handsome, showy pet and fun to train. It is, however, extremely noisy and loves to hear its own screeches. (*See also* Parrots).

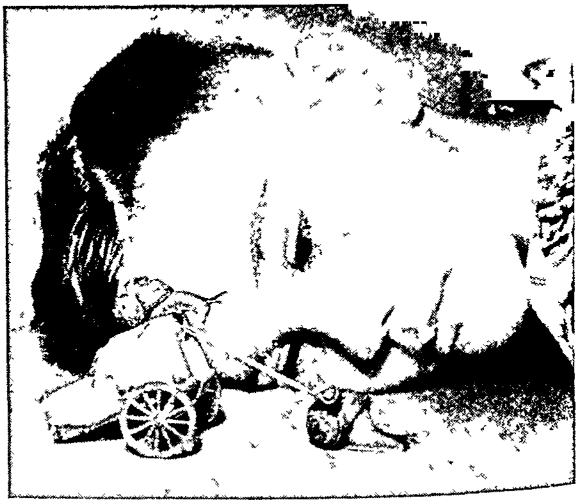
Canaries have been popular ever since they were brought from the Canary Islands to Europe in the 16th century. There are two large groups—the *type* canary, which is bred primarily for its plumage and lines; and the *singing* canary, bred chiefly for its song. In shows, type canaries are judged for conformation to the Canary Club's standards; singers are judged only on song, style, and condition.

The various breeds of singers look much alike—it is the song that distinguishes them. Only the male sings. The singers are *rollers* and *warblers* (sometimes called *choppers*). A roller's song is soft, with rolling notes, and is marked by "tours"—a series of musical notes repeated during the song. The roller sings from its throat, its beak almost shut. A warbler throws back its head, puffs its throat, opens its beak wide, and pours out a clear, joyously robust song. Your pet will not sing when it molts.

The size of the cage for your canary depends upon the bird. For most breeds a good cage is oblong in shape, with a base at least 9 by 15 inches. Clean the cage every other day and, just before cleaning, give your bird its bath dish. Your pet will enjoy a swing or Ferris wheel hung from the top of the cage. If the cage is in a room which is lighted until late, cover it at night so your bird can sleep.

Feed it once a day, preferably in the morning. Rollers should be fed a special roller mixture. Warblers and type canaries get a prepared mixture of a greater variety of seeds. Your bird should also get daily greens, such as the leaves from celery or broccoli, or carrots, twisted around a wire of the cage. Keep a seed ball hung in the cage and a cuttlebone clipped to the wires. Change the cuttlebone monthly. Keep canary gravel in a treat cup. For the molting season, pet shops carry additional foods such as wheat-germ meal. (*See also* Canary Bird.)

AN ORPHAN WOODCHUCK BECOMES TAME
The children's mother raised this gentle woodchuck after its own mother was accidentally killed. It has its own burrow.



THIS TOOK PATIENT TRAINING
Many boys and girls have pet snails, but this lad has "racing snails." One pulls the other in a homemade tin Roman chariot.

Tropical Fish and Goldfish

Among the most beautiful and interesting pets for older children and adults are tropical fish. The magnificently colored "troppies" soon fascinate you with their flashing grace. In many homes the tropical aquarium is part of the interior decoration.

When you start collecting tropical fish, consult your pet shop, for the different varieties have special needs. Here, however, are a few general rules for all troppies. Before you buy the fish, get an aquarium, gravel, and greenery. An aquarium with straight sides is best, because curved glass distorts the lines of the fish. Put the aquarium where it gets light but not in day-long direct sunlight.

When buying troppies, start with the cheaper kinds, such as black mollies or angelfish. When you are ready to add to your collection, ask your pet shop what other kinds will live well with your original troppies. Do not mix very large fish with small species. Do not crowd the aquarium—try to have one gallon of water for one inch of fish, not counting the tail. Crowding and overfeeding are the most common causes of aquarium sickness and death.

Whatever the species, your pets need a variety of food. Feed them once a day, preferably within a floating feeding ring, put always in the same place. They soon learn to come up for food when you tap the aquarium glass or click your fingernails. Do not frighten them by a sharp noise or by flashing a light in the aquarium. If you must go away a day or two,

they can live on the greenery and remnants of food.

To lift a fish, use a net. Do not pick a fish up with your hand; you might break the film that covers the scales. If your fish keep coming to the top of the water other than at feeding time, they probably need more air in the water. There are special pumps to bubble air through the aquarium.

The first popular tropical fish was the guppy, a tiny fish that bears its young alive. The female is dark in color and about one and a half inches long. The male is one inch long and brilliantly colored. Many people start their aquariums with guppies—peaceful little fish and amazingly sturdy. (For picture of tropical fish in natural colors, *see* Fish; for aquarium species and care of aquariums, *see* Aquarium; for native fish aquarium, *see* Nature Study.)

Goldfish were the first popular aquarium pets. They are hardy, showy members of the robust carp family. As they need less care than tropical fish they are more suitable than troppies for younger children. They can be kept in a globe or even in a glass jar, if you leave considerable space for air above the water. An oblong aquarium, however, is much the best.

Feed goldfish once a day and vary their feeding. Your pet shop has inexpensive foods; so give them two or three changes a week. You can also occasionally give them a bit of crumbled dog biscuit or a bit of chopped egg or liver. (*See also* Goldfish.)

White Mice and Squirrels

Two of the liveliest pets are white mice and squirrels. They are natural acrobats and can be taught tricks. For a pair of mice the cage should be about two feet square and two feet high. A movable nest box with a lid and a hole in one side may be fixed to one side of the cage. Line the nest box with excelsior or fine paper strips. Hang a trapeze in the cage and keep a small piece of hardwood for them to gnaw. Wash the cage weekly.

Feed your mice bread crusts, uncooked rice, cracked corn, sunflower seeds, a bit of carrot or apple, crumbled dog biscuit, and skimmed milk. Do not feed them sugar, salt, or cheese. They are very thirsty and must have fresh water handy at all times.

A squirrel should have an exercise wheel in its roomy cage. When feeding or petting a squirrel be careful because if frightened it nips or scratches. A flying squirrel, however, is an unusually gentle pet. You can feed a squirrel rabbit food pellets, greens, and all kinds of nuts except salted nuts. (For care of squirrels, *see* Squirrel.)

Turtles—Water and Land

The easiest pet to care for, perhaps, is a turtle—when you know how. The water turtle can eat only under water. It needs at least two inches of water, and there should be a piece of wood or stone sticking out above the surface. You need feed it only once a week and must clean the aquarium the day after feeding.

Land turtles need no water except what they get from their food, but they enjoy an occasional dip in a bowl. Do not feed a turtle with your fingers. Turtles have no teeth, but their hard jaws can nip. If you give land and water turtles prepared foods, add raw foods. (For care and feeding, *see* Turtle.)

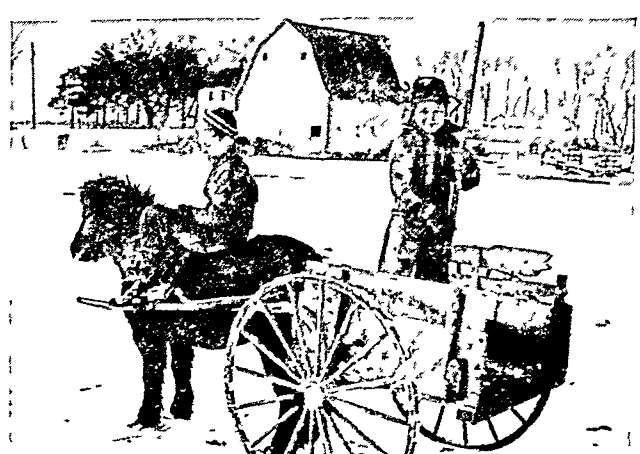
Painting or enameling a turtle's shell prevents its growth. If you get a decorated turtle, remove the decoration, a little at a time, by gentle scraping or daubing lightly with turpentine or nail polish remover.

Terrariums, Ant Houses, Crickets

In your own home you can see how small wild animals and insects live in natural surroundings in a *terrarium*. This is a glass case planted with suitable foliage. You can watch a frog and snails in a "woodland bog" terrarium; or a horned toad, lizard, snake, and tortoise in a "desert" terrarium.

An ant house, like a terrarium, is an especially fine interest for shut-ins. It takes little care and is full of fascinating action as the busy creatures skitter about (*see* Ant). (For directions on how to make an ant house and a terrarium, *see* Nature Study.)

Crickets are tiny but lively and cheerful pets. Tree crickets even "tell" temperature. In China and Japan



ONE FARM PET GROWS UP, ONE GOES TO WORK

The curly headed boy holds a baby milk bottle for an orphan lamb on a Kentucky farm. Pet lambs are lively and love attention.

Shetland ponies are tiny but strong. This little fellow, in its shaggy winter coat, earns its oats hauling the boys' farm cart.

PETS FROM THE CITY AND ONE FROM THE WOODS

Some cities hold annual pet parades. In this one, pets and owners wear homemade costumes. The pets seem to like their "finery."

A merry raccoon makes friends at the county Trailside Museum near Chicago, Ill. School classes visit this wildlife refuge.

adults carry cricket cages as they stroll on summer evenings. (For care, *see* Cricket.)

Pigeons and Farm Pets

Even in large cities some people keep pigeons, as racers or as fancy breeds. They have cotes in back yards or on rooftops. The cote must be secure against mice and rats. It should face south and be well ventilated. Fix a six-inch landing shelf both inside and outside the entry holes. Feed them prepared pigeon grain, adding hemp or millet seed as a weekly treat. They must have salt and grit and always fresh water. (For breeds, *see* Pigeons and Doves.)

Nearly every farm child takes a baby animal and raises it as a pet. Farm children soon learn too that piglets, ducklings, and goslings are usually smart in their own way and can learn to do tricks. Even chickens, lambs, and calves can be trained. Farm pets are fortunate, for their young owners know how to care for them. (For pictures, *see* Farm Life.)

Wild Animals and Trailside Museums

Television programs show fascinating wild animals, some of them trained as pets. Raccoons, skunks, and ground hogs (or woodchucks) are popular. All these can be tamed (*see* Ground Hog; Raccoon; Skunk). Monkeys, even when trained, are mischief-makers with quick tempers and are usually kept chained even when performing tricks (*see* Monkey).

Few city children can have wild animals as pets. Many communities, however, have trailside museums where children can learn how to help care for animals. A number of cities have animal "lending libraries," which teach pet care and permit children to take home a pet for a week or two. Some zoos have children's zoos, where youngsters can play with animals (*see* Zoo).

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PETU'NIA. The beautiful garden flower the petunia is a native of South America. Since the 19th century it has been cultivated in other countries. Through hybridizing, rich shades of crimson and rose, magnificent purples, and a number of spotted and striped varieties have been introduced. Some species too have deeply ruffled and fringed corollas and some are double. The plant, except in the dwarf varieties, has

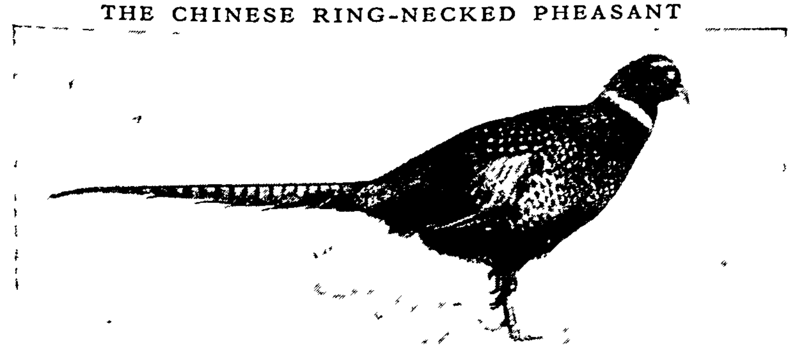
a tendency to sag and sprawl about the ground with many upright flowering branches. The finest flowers are produced in deep rich soil in sunny places. They make attractive beds and borders and are also grown as hothouse and conservatory plants. The petunias are hybrids usually of *Petunia nyctaginiflora* or *Petunia violaceae*. They belong to the same family as the nightshade (*Solanaceae*).

PHAETHON (*fā'ĕ-thŏn*). This daring and beautiful youth, whose name means "the shining one," was the son of Helios, the sun-god of the Greeks (sometimes identified with Apollo), by the nymph Clymene. In a moment of rashness Helios swore by the sacred river Styx that he would grant his son anything he asked. Phaethon asked the one thing that his father would have refused him—to be allowed to drive the chariot of the sun. God though he was, Helios dared not break his solemn promise, so Phaethon's wish was granted.

Phaethon started boldly on his journey across the heavens but very soon lost control of the fiery horses of the sun. Rushing headlong from the beaten track, they drew the sun so low that the mountain tops were scorched and finally even the trees and the grass and the grain in the fields were burnt. When Zeus saw that the whole earth was about to be destroyed, he seized one of his thunderbolts and hurled it at Phaethon, who fell like a shooting star into the river Eridanus, now called the Po. His sisters, the Heliades, who stood on the bank weeping, were turned into poplar trees, and their tears, it is said, fell into the stream and became amber.

PHEASANT (*fĕz'ănt*). The pheasant is a large game bird with brilliantly colored feathers, related to the partridge and grouse. The males have long, showy tail coverts. Pheasants are found in greatest abundance in England, where they are supposed to have been introduced by the Romans; but they may have been native to both the British Isles and southern Europe.

THE CHINESE RING-NECKED PHEASANT



The Chinese ring-necked pheasant is now one of the most abundant game birds in eastern, northern and midwestern United States. Many thousands are raised in state game preserves and by farmers. The male is a beautiful bird, with greenish-purple head, coppery breast, and orange-brown back and tail.

The common English pheasant (*Phasianus colchicus*) is about three feet long, including the tail, which represents half the length of the bird. The plumage is beautifully mottled brown and buff, with changeable lights of blue and green over the breasts of the males. Great numbers of these birds are raised and fed artificially and liberated in game preserves on English estates. The practice of raising these birds in domestication is now common, the numbers so raised vastly exceeding those that breed wild. Eggs are collected from birds that are either running wild or kept in pens. They are hatched in incubators or by domestic hens, who make good foster mothers for the young pheasants.

PROTECTIVE COLORATION OF PHEASANT

The male English pheasant seems easily alarmed, but the female will remain on her nest until the hunter is almost upon her, hoping he will pass on without noticing her. The nest is built on the ground, usually among dead leaves or branches, and the female hatches 10 to 12 eggs at a time.

Chinese ring-necked pheasants were introduced into the United States about 1880 in Oregon. About the same time English pheasants were established in the eastern states. Most pheasants of eastern North America today are descendants of crosses between the English and the ring-necked. True English pheasants lack the white ring around the neck. Pheasants are now far more numerous than the native grouse and quail. The ringneck is the state bird of South Dakota. (For picture in color of the egg, *see* Egg.)

The male ringneck is about three feet long, including the tail. The head and neck are metallic green and purple, with a white ring about the neck. The females are a mottled brown and black.

Pheasants are raised by state game commissions, by commercial game breeders, and by farmers. Aviary, or fancy, pheasants are raised for zoos and parks. The golden and the silver pheasants are especially beautiful. Scientific name of ringneck, *Phasianus colchicus torquatus*.

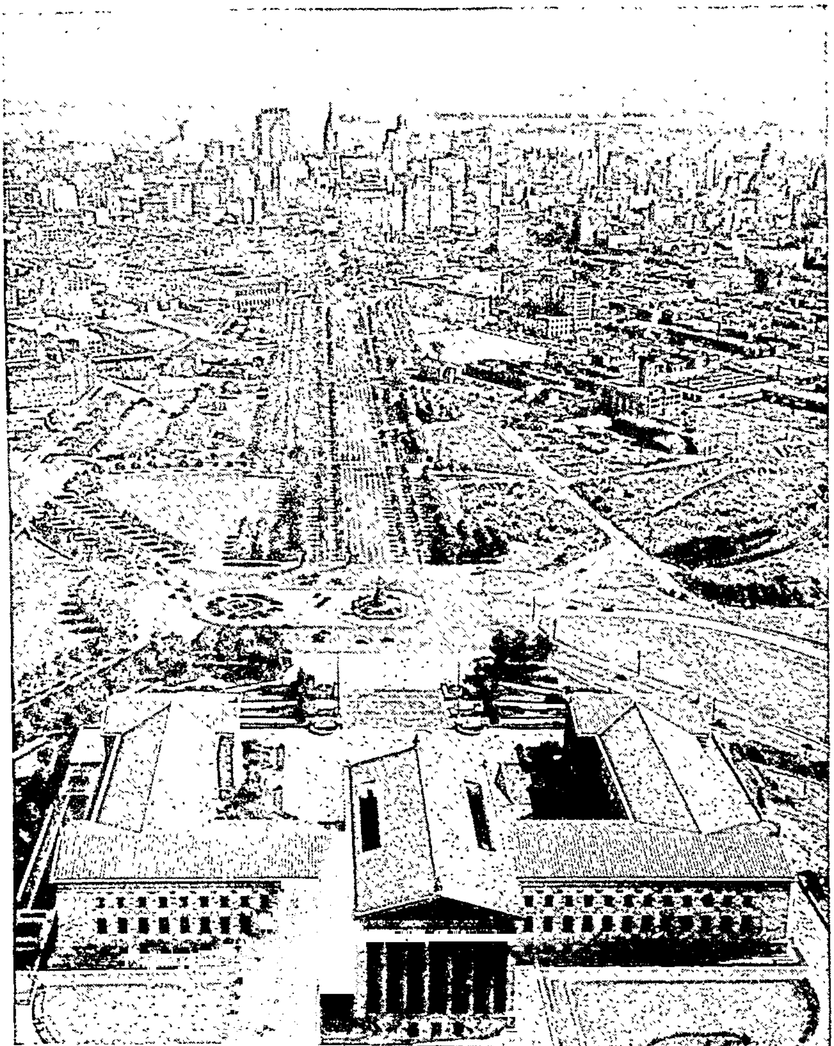
PHIDIAS (*fĭd'ĭ-ăs*) (about 500–430 B.C.). The greatest of all Greek sculptors and one of the greatest in all history was the Athenian Phidias, who alone, it was said, had seen the gods and made them visible to others. The information about his life is scanty and often contradictory. For our knowledge of his work, also, we are largely dependent on the statements of ancient writers, as no certain original of his hand has survived, although miniature copies show the designs of his greatest statues.

Phidias was born at Athens about 500 B.C. When he reached young manhood there came to him such

an opportunity as comes to but few artists. He was appointed by Pericles, who had risen to the head of affairs at Athens, to superintend the adorning of that city with fine public buildings and to execute the most splendid of the statues to be erected. It was largely through the genius of Phidias that Athens was made the most beautiful city in Greece, with more temples, colonnades, and other works of art than were constructed in seven centuries in Rome. He supervised the construction of the Parthenon, the magnificent temple of Athena on the Acropolis; and while the sculptured ornaments of this building were probably executed by his pupils, the giant statue of Athena, in ivory and gold, which stood inside the temple, was the work of Phidias himself (*see* Acropolis). His masterpiece was a colossal gold and ivory statue of Zeus for the Olympian temple in Elis, ranked for its majestic beauty among the wonders of the world.

In his later years Phidias was accused of appropriating a portion of the gold designed for the robe of Athena. He disproved the charge; but he was then charged with impiety in having placed his own likeness and that of Pericles upon the shield of the goddess. He was thrown into prison, where he died about 430 B.C. (*See also* Sculpture.)

The STATELY *Old City of* WILLIAM PENN



The Benjamin Franklin Parkway extends 1½ miles from the Art Museum, in the foreground, to the City Hall, the towered building in the background. Midway along the Avenue is Logan Square. On the left is the Free Library, on the right, the Franklin Institute. More than a thousand buildings were torn down to make this spacious parkway.

PHILADELPHIA, PA. William Penn, in his broad-brimmed Quaker hat and full-skirted Quaker coat, stands 37 feet tall on City Hall tower, 548 feet above the pavements of his "dear Philadelphia." From his lofty height he looks over the third largest city in the United States, rich in historic associations, and a leading seaport and manufacturing center. It lies along the west bank of the Delaware River and on both sides of the Schuylkill River. Although it is 90 land miles from the Atlantic Ocean, a deep channel from the Delaware River to Delaware Bay permits ocean-going vessels to call at its roomy harbor.

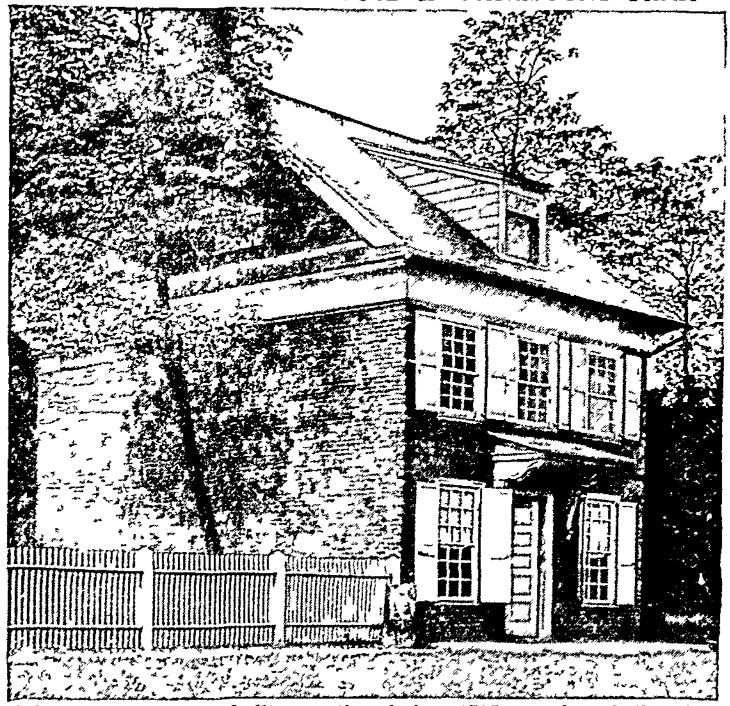
The City Hall stands at the intersection of Broad Street, which cuts through the city from north to south; Market Street, the main east-west axis, and the Benjamin Franklin Parkway, which starts here and extends to the northwest. Broad and Market were laid out when the city was planned in 1682. Twice as much space was given to streets as was then usual. The "gridiron" plan of streets crossing at right angles has been generally followed in other American cities.

Skyscraper office buildings, great department stores and shops crowd about this busy intersection and along Market to the east. The runaway printer's apprentice named Benjamin Franklin, who walked here one morning in 1723, munching a loaf of bread while a pretty girl laughed at him from a doorway, would little recognize Broad and Market today. But he might feel more at home in Independence Square, a few blocks to the southeast of the City Hall. Here are some of America's most famous landmarks. The State House, now known as Inde-

pendence Hall, was built between 1732 and 1741. In this hall the Second and Third Continental Congresses met; Washington was made commander in chief of the American armies; and the Declaration of Independence was adopted, while the Liberty Bell (now preserved on the main floor) pealed forth "liberty throughout all the land." Here too the Articles of Confederation were ratified, and the Constitution was framed.

Adjoining Independence Hall on the west is Congress Hall, where Congress sat from 1790 to 1800 when Philadelphia was the nation's capital. Washington was inaugurated here in 1793, and John Adams in 1797. Washington delivered his farewell address to the American people from this Hall in 1796. On the east of Independence Hall is the old City Hall, built in 1791, where the Supreme Court sat while Philadelphia was the capital. East of the square is Carpenters' Hall, where the First Continental Congress assembled in 1774. In addition to these buildings, Christ Church (1754), the site of Franklin's home, and several colonial houses are to be included in the Independence National Historical Park, authorized by Congress in 1948.

THE LETITIA STREET HOUSE IN FAIRMOUNT PARK

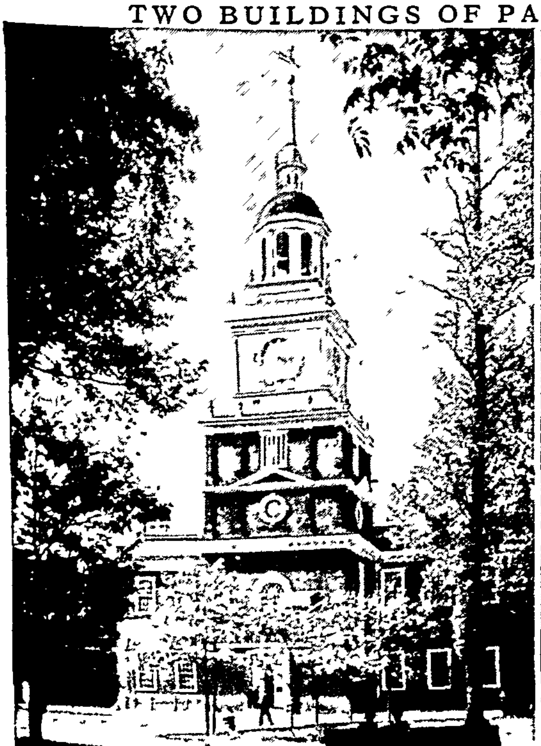


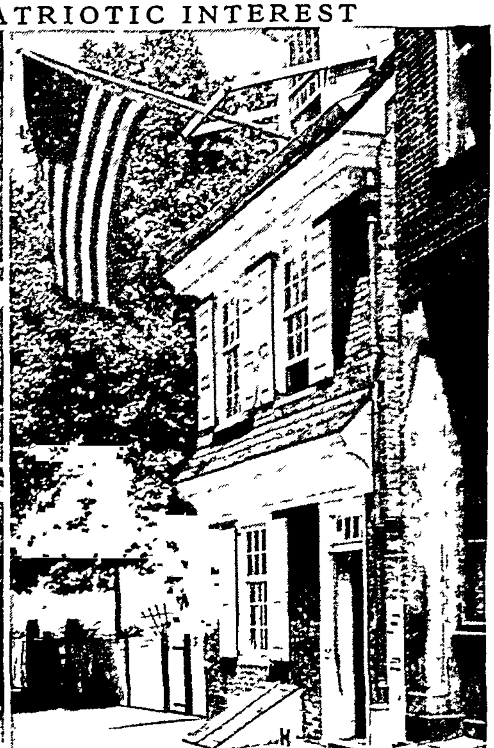
This little brick house, built some time before 1715, was long believed to be the home of William Penn. Recent research, however, has revealed that the Penn house built in 1682 was destroyed long ago.

The Benjamin Franklin Parkway extends for 1½ miles from the City Hall to the Philadelphia Museum of Art. Midway along the Parkway is Logan Square, with a fountain, flower beds, and benches. Between the Square, and the Museum are the Academy of Natural Sciences; the Free Library; Franklin Institute, containing a museum and the Fels Planetarium; and the Rodin Museum (*see* Rodin). The Museum of Art, of classic Greek design, stands on a low hill looking down the Parkway. Beyond it, to the northwest, Fairmount Park (3,845 acres) extends for 10 miles along the Schuylkill River and Wissahickon Creek. In the park are the Aquarium; Horticultural Hall; the Zoölogical Gardens; Robin Hood Dell, a natural amphitheater where concerts are held in summer; and several colonial mansions, which have been restored.

Farther north, though still within the city limits, is Germantown, with its old mansions. Around the Chew mansion raged the battle of Germantown in 1777. Among other points of interest

TWO BUILDINGS OF PATRIOTIC INTEREST





Independence Hall (left), where the Declaration of Independence was adopted, is one of America's most historic buildings. It is also a notable example of Georgian colonial architecture. In the Betsy Ross house (right), according to popular belief, the first American flag was made.

are Rittenhouse Square, south of the City Hall, once a fashionable residential neighborhood; the house in which Edgar Allan Poe wrote some of his famous tales; the United States Mint; and League Island Navy Yard with its warships and naval aircraft factory.

Many Educational Institutions

The University of Pennsylvania, founded in 1740, occupies a 120-acre campus in west Philadelphia. Girard College, opened in 1848 as a school for orphan boys, was founded by Stephen Girard, banker, merchant, and philanthropist. Other notable institutions include Temple University; Drexel Institute of Technology; the Academy of Music, home of the Philadelphia Symphony Orchestra; the Curtis Institute of Music; and the Pennsylvania Academy of Fine Arts. Only 11 miles from the heart of the city are Swarthmore College and Bryn Mawr College for Women.

The City's Varied Industries

Philadelphia's advantages of location helped it to become one of the country's greatest industrial and commercial centers. Even in colonial days it was a leading port. The Pennsylvania Railroad, one of the nation's chief carriers, makes Philadelphia its general headquarters. Two airports provide modern air facilities.

The city's situation as the Atlantic outlet for Pennsylvania's coal and oil makes it a manufacturing center as well as a great commercial port. The Philadelphia industrial area rivals that of Los Angeles in the value of its petroleum products. It is a leader in metals and metal products, textiles, chemicals, leather and rubber goods, refined sugar, paper, radios, and hats. The Baldwin Locomotive Works in the suburb of Eddystone and the E. G. Budd Manufacturing Company supply the nation with locomotives and streamlined trains. The Curtis Publishing Company is one of the largest magazine publishers in the world.

Founded by Quakers

Philadelphia was founded by the Quaker, William Penn, in 1682 (*see* Penn). He gave it the name of the Biblical city in Asia Minor, which means in Greek, "City of Brotherly Love." It was the capital of Pennsylvania from 1685 to 1799, and the capital of the nation under the Articles of Confederation from 1775 to 1789, and under the Constitution from 1790 to 1800. Among its notable citizens were Benjamin Franklin, Robert Morris, Dr. Benjamin Rush, John Fitch, and Stephen Girard.

Two memorable events have been the Centennial Exposition of 1876 and the Sesquicentennial Exposition of 1926, celebrating the 100th and 150th birthdays of the nation. Philadelphia has long been a popular convention city. Here Zachary Taylor was nominated for the presidency in 1848; William McKinley in 1900; F. D. Roosevelt in 1936; and Harry Truman in 1948. A traditional pageant is the annual New Year's Day Mummers' Parade, first held on Jan. 1, 1901. Philadelphia has the mayor-council form of government. In November 1951 the city elected a Democratic mayor (Joseph S. Clark, Jr.) for the first time in 67 years. Population (1950 census), 2,071,605.

PHILIP, KINGS OF FRANCE. The name Philip was first introduced into the royal line of France in the 11th century by the French queen, Anne. She was a daughter of the Russian czar and claimed descent from the great king Philip of Macedon (*see* Macedonia). Her son was Philip I of France, who came to the throne in 1060 at the age of eight and ruled till 1108. He was the first of six monarchs to bear that name. But only three were important.

PHILIP II, 1180–1223, is best known by his title "Philip Augustus". He was so called, according to a chronicler of the times, because "he enlarged (*augere*, "to increase") the boundaries of the state as the Emperor Augustus enlarged those of the Roman Empire." He was a contemporary of Richard the Lion-Hearted of England and of Frederick Barbarossa of Germany. All three went on the Third Crusade to recapture the Holy Sepulcher from the Mohammedans under Saladin. But Philip soon took advantage of a quarrel with Richard and returned home. From that time until the end of his reign he successfully devoted himself to enlarging his kingdom and increasing his power.

When he came to the throne the land that he actually ruled was merely a small territory around Paris. Most of the present kingdom of France was held as a fief by the King of England, with whom the French ruler was frequently at war. From King John, Richard's successor, Philip took a great part of the continental possessions of the English kings, including Normandy, their homeland. Philip II also strengthened his control over all classes of his subjects, and by encouraging the towns he lessened the influence of the powerful feudal lords. Paris then first became the regular capital of the realm, and the building of the great cathedral of Notre Dame was carried far toward completion.

One event mars the reign of this king. This was the crusade against the Albigenses, a heretical sect in southern France. Philip himself did not join the attack but he permitted his son Louis to take part. In the crusade, thousands of people were murdered and one of the fairest parts of France devastated; but the attack increased royal territory.

A Handsome and Powerful Ruler

PHILIP IV, 1285–1314, called "The Fair" because of his good looks, is the next Philip of France who is historically important. He was the first example of a French king who had both the will and the means to become a powerful monarch. He set a mark upon French life and government which has not been wiped out by the floods of successive revolutions. His reign was notable chiefly for the development of the royal power, the increase in taxation, the meeting of the first session of the Estates-General (a national assembly corresponding to the English Parliament), and for his struggle with and triumph over Pope Boniface VIII.

To understand this struggle one should note that Philip was at war with England and with Flanders, and to carry on these wars he needed money.

After taxing the laymen all he could, Philip turned to the rich churchmen for money. But the pope claimed that church property was not under the jurisdiction of the state and could not be taxed, and he forbade the priests to pay the taxes levied by Philip. In the end the king not only won the conflict with the church, but he also secured the removal of the popes from Rome to the southern border of France, where they were more easily subjected to French influence. This was the period of the "Babylonian Captivity" of the church which lasted for 70 years (*see* Boniface).

PHILIP VI, 1328–1350, was not personally of especial importance, but his accession to the throne is noteworthy because of momentous consequences for both France and England. In 1328 the last Capetian king of France, Charles IV, had died without a son, and there arose the question of succession to the throne. It was decided, following a precedent set in 1314, that a woman could not rule over France, and the new principle was now added that she could not hand on her claim to a son. The throne, therefore, went to Philip of Valois, the nearest descendant in the male line, who became Philip VI of France.

His chief rival was young Edward III of England, whose mother was the sister of Charles IV. At first this decision was accepted by all, but in 1337 Edward III of England denied the justice of it and laid claim to the throne of France on the ground that he stood nearer in relationship to the last preceding king than did Philip of Valois.

Edward's claim was one of the grounds for the Hundred Years' War, which was waged, except for brief intervals, until 1456, and which ended by England losing all its possessions in France except Calais. It was this, in fact, which led England to turn its attention to the seas, where it soon reigned supreme. The war also helped the king of France to consolidate his power into the absolutism which existed until 1789.

PHILIP, KINGS OF SPAIN. At the end of the reign of each of the Philips of Spain the country was a little weaker politically, a little poorer industrially, than it was when he began to rule. The first, third, and fourth of the name were so characterless that they have left no trace of their personality. Philip V —the first of the French, or Bourbon, kings—was "distinguished for few faults and few virtues"; but the weak-minded man is important because of the devastating War of the Spanish Succession (1701–13) by which he gained his throne (*see* Louis, Kings of France).

PHILIP II in 1556 took up the burden of ruling Spain when his father Charles V laid it down, and he continued to carry it until his death in 1598. At the start of his reign his kingdom included Spain, the Netherlands, parts of Italy, and the Spanish possessions in the New World. The other possessions of Charles V went to Charles' brother Ferdinand, head of the Austrian Hapsburgs. During his rule Philip lost the Netherlands, but seized control of rich, weak Portugal (*see* Portugal).

He was 28 years of age when his father abdicated, but he was prudent and experienced beyond his years. Dull and plodding, he was determined to do his best and to sacrifice everything to his view of duty. Unfortunately, though he was conscientious and well-meaning, he believed that his mission in life was to win world-wide power for Spain and the Roman Catholic church. His first wife, the Catholic Queen Mary of England, died two years after he became king, and he had small chance after that to win England for Spain with Queen Elizabeth I as his rival. He was no match for her in international intrigue, and even his effort to conquer England by force was a failure, for the expedition of the Invincible Armada in 1588 ended in disaster (*see* Armada, Spanish).

THE KING WHO LOST SPAIN'S POWER

Philip II had far-reaching ambitions which brought him into conflict with leaders greater than himself. He suffered reverses at the hands of Elizabeth I of England, Henry of Navarre, and William of Orange. The picture is from a portrait by Titian.

This defeat alone would not have wrecked Spain, but Philip's policy had weakened the country in other ways. His intrigues in France against the Huguenots and in behalf of the Catholic League were frustrated by the victories which brought the Protestant-bred Henry of Navarre (Henry IV) to that throne (*see* Henry, Kings of France).

In his desire to extend the power of the church he had also encouraged the Spanish Inquisition, and he scattered over all Spain the Moriscos of Granada, the thriftiest of his people (*see* Moors). However, his efforts to stamp out Protestantism in the Netherlands by the same means led in 1568 to a revolt under William of Orange and to the final independence of the Dutch Netherlands, or Holland (*see* Netherlands; William, the Silent).

The PHILIPPINES *and Their Freedom-loving* PEOPLE

Self-rule Returned to the Philippines March 8, 1945, When President Osmeña (Left) Swore in His Cabinet

Extent.—Extreme length of archipelago, north to south, about 1,100 miles, east to west, nearly 700 miles. Total area, 115,600 square miles, of which about two-thirds is contained in Luzon and Mindanao. Population (1948 census), 19,234,182.

Natural Features.—About 7,083 islands, largely of volcanic formation, traversed from north to south by irregular mountain chains. Highest peak, Mount Apo (on Mindanao), 9,610 feet. Moist tropical climate, with frequent hurricanes and earthquakes.

Products.—Rice, sugar, coconuts, abaca (Manila hemp), corn, tobacco, rubber, sweet potatoes, pineapples, bananas; gold, iron, copper, silver, chromite, manganese; lumber and forest products.

Cities.—Quezon City (official capital, 107,977); Manila (actual capital, 983,906), Cebu (167,503); Davao (81,523); Iloilo (46,416); Baguio, old summer capital (29,262).

PHILIPPINE (*fĭl′ĭ-pēn*) **ISLANDS.** On July 4, 1946, the Philippine Islands became completely independent as the Republic of the Philippines. It was the first nation in the Far East to achieve democratic government and the first foreign-owned colony of the Asiatic world to gain its freedom. Under Spanish rule, the Filipinos had been the first Oriental people to become predominantly Christian. As wards of the United States, they had learned the meaning and practise of democracy.

As the Filipinos approached their goal of nationhood their land was ravaged by four years of war and enemy occupation (*see* World War, Second). They were in the final stages of their apprenticeship in self-government when the Japanese attacked in 1941.

The United States, which had acquired the islands from Spain in 1898, had established a Commonwealth government and had set the date of July 4, 1946, for their full independence. The war interrupted everything, laid waste towns, mines, industries, and farms, and brought untold suffering to the people. Yet it served to increase the patriotism of the Filipinos and their desire for freedom. Their last-stand defense on the Bataan peninsula at the side of United States troops was one of the most heroic in history, and their unremitting guerrilla and underground warfare weakened the Japanese and helped pave the way for the liberating armies of General Douglas MacArthur.

Geography of the Islands

The Philippines consist of a broken chain of islands which cuts off the South China Sea from the Pacific Ocean. The northernmost islet of the Philippines lies only 65 miles south of Formosa. At the other end, two links of the chain reach into the coastal waters of Borneo. To the northwest lies the coast of China, to the west the coast of Indo-China

The nearest point on the coast of the United States is 7,500 miles away on the other side of the International Date Line. This means that the calendar date changes in the Philippines before it does in the United States. For example, when the Japanese planes first attacked the islands in midmorning of *Monday, December 8*, it was the evening of *Sunday, December 7*, in Washington, D.C. (*see* Time).

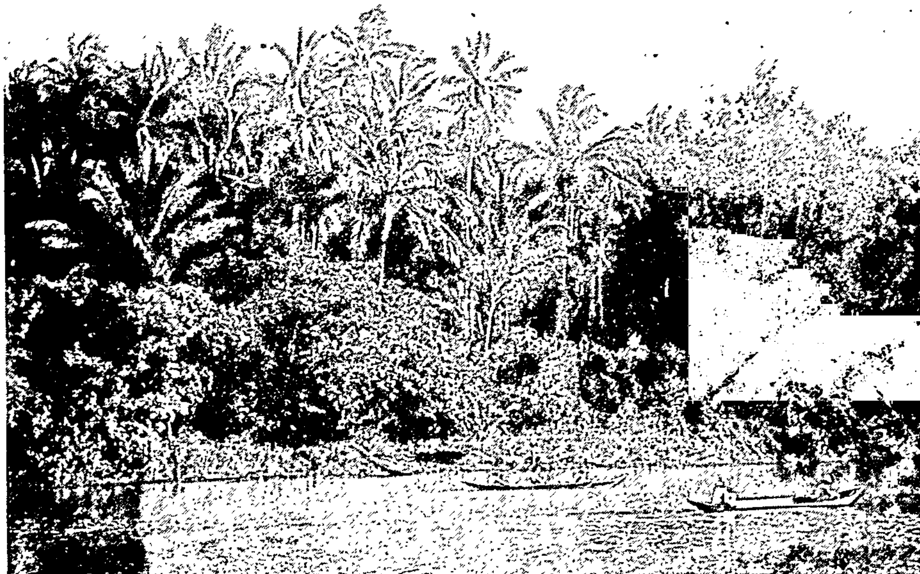
In the geographical sense, the islands belong to the archipelago of the East Indies (*see* East Indies). Like the other East Indian islands, the Philippines are part of a vast submarine mountain range some of whose peaks and ridges are high enough to rise above the ocean's surface. The typical island of this group

has a high, rugged interior with a fringe of narrow coastal plains. Only a few contain wide valleys suitable for farming.

Included in the boundaries of the country are 7,083 islands but many are mere rocky points peeping out of the sea or wave-washed coral reefs (*see* Coral). Only 462 are larger than one square mile, and less than 1,000 are inhabited. The total area of the islands is about 115,600 square miles. The two largest islands are Luzon, the size of Ohio, and Mindanao, as large as Indiana. They account for two-thirds of the area. Other islands rank in size as follows: Samar, Negros, Palawan, Panay, Mindoro, Leyte, Cebu, Bohol, and Masbate.

Fifty or more of the mountain peaks are volcanic, and several craters are active. Earthquakes frequently rock the land. Mount Mayon in southern Luzon, the most beautiful of the volcanoes, lifts a perfect cone almost 9,000 feet into a perpetual cloud of vapor. Taal, in the midst of a lake south of Manila, has a crater holding lakes of many-colored liquids. Mindanao contains Mount Apo, the highest summit (9,610 feet). Off the northeast coast of this island is Mindanao Deep. This is one of the deepest places in the world's oceans. The bottom is nearly 35,000 feet, or 6.5 miles, below the surface.

CONTRASTS IN PHILIPPINE LANDSCAPES



At the top, the rice terraces of the Ifugao tribesmen rise step by step toward the mountain top, in northern Luzon. These primitive farmers have built an intricate irrigation system to carry water to their crops. At the bottom we see a typical rain forest of the Philippines. It is so dense that travelers are glad to follow the watercourses.

The rivers of the Philippines are usually short and swift. The only ones that exceed 200 miles in length are the Cagayan on Luzon and the Pulangi (called the Rio Grande de Mindanao near its mouth) and the Agusan on Mindanao. The largest lake is Laguna de Bay, near Manila. Lake Lanao and its outlet, the Agus River, in northern Mindanao offer enormous potential water power. Their waters plunge to the sea through many rapids and over Maria Christina Falls.

The Heat and Rain of the Tropics

The Equator lies less than 400 miles south of Mindanao, and the Tropic of Cancer only 300 miles north of Luzon. So the entire archipelago feels the continual heat and humidity of the tropics. The temperature varies little from season to season, and frost comes only to the higher mountains. Cool ocean breezes often moderate the heat.

Rainfall is heavy, averaging as high as 120 inches annually in some places. From May through October the southwest monsoon wind brings rain chiefly to the west coast of the islands. From November to April the monsoon blows in the opposite direction, making the east side rainier (*see* Winds). The variation between wet and dry is most marked in the

north. The south is likely to have heavy rains at any time of the year.

In the early autumn the much-dreaded typhoon, or *baguio*, often sweeps in from the southeast to do its deadly work. Hour after hour the rain descends, driven almost horizontally before a furious gale, overturning houses and sending roofs and shutters sailing away. Floods turn mountain streams into torrents that wash away crops, bridges, and buildings. The typhoon strikes chiefly in the section north of Manila.

Tropical Plants and Animals

Rain-forest vegetation clothes this rugged land in beautiful and bewildering variety, from the useful, fast-growing bamboo to the pines of the high ridges. There are about 3,000 species of trees that grow to a diameter of a foot or more, and the tallest may reach a height of 250 feet. Exotic blooms paint brilliant patterns against the forest green. Where trees and vines have been burned away for primitive farming, tough cogon grass springs up, choking out the tender plants, and creating vast stretches of grassland amid the forests. The familiar tropical fruits, such as oranges, limes, and bananas, grow here, as well as varieties that are not so commonly known—lansons, santols, jack fruits, papayas, and guavas.

The vivid feathers of such tropical birds as lorikeets, parrots, parakeets, and cockatoos flash amid the jungle growth. The monkey-catching eagle hunts his prey. Hornbills sound their raucous call. In addition to many of the birds of Europe and America, a great number are peculiar to the East Indies and the near-by lands of Asia.

The wild animals, too, are like those of Asia except that the large mammals are missing. Bats are common—small ones as well as the giant fruit bats, or flying foxes. Monkeys and their relatives include the tarsier and lemur. Deer and wild pigs are hunted as game. Civets and wildcats prey on birds and smaller animals, and mongooses feast on snakes and rats.

Reptiles range from the tiny lizards that slither over every wall and ceiling to the great crocodiles that lurk in jungle swamps and rivers. Cobras and tiny green pit vipers are the only poisonous snakes. Small pythons are kept as pets in native houses to catch rats and mice.

Insects swarm in the humid air. The seas teem with colorful fishes and coral-reef animals. The waters of the Sulu archipelago produce pearl oysters.

The Filipino Peoples

These fertile, rain-swept, tropical islands support more than 19 million people. They are a small, slender graceful folk with brownish-yellow skin, black eyes, and heavy, straight, black hair. Nearly all of them belong to the same Mongoloid stock, sometimes called Malayan, which peoples the islands and the mainland to the southwest. They came to the Philippines centuries ago in waves of migration. Scholars have found 43 separate cultural groups on the archipelago distinguished from one another by different folkways and racial characteristics. Eighty-seven languages and dialects are spoken. These differences have arisen from the long isolation of groups on remote islands, or in out-of-the-way valleys. Improved communication and travel and the spread of public schools are gradually erasing the differences among Filipinos and making them a unified people.

The best known among the Filipino peoples are the peaceful, farming folk whom the Spanish explorers of the 16th century found living along the coasts and in the valleys of the north and central islands. They had a written language and other elements of civilization. They were converted to Christianity by the Spanish missionaries, and through the years have adopted Western ideas and ways. They have been most active in the development of education and democratic government. The most prominent and progressive are the Tagalogs, who live in the central Luzon plain near Manila. The Visayans, who inhabit the central islands around the Visayan Sea, outnumber the other tribes.

The most formidable people with whom the Spaniards and Americans had to deal were the Moros, who had been converted to Mohammedanism by Arab missionaries. An aggressive, warlike people, they roamed the inland seas in outrigger canoes with huge, bright sails, seizing the cargoes of peaceful craft and hunting slaves among the farming tribes. Driven from the northern islands by the Spaniards, they concentrated in Mindanao and in the Sulu (or Jolo) islands southwest of it. They resisted American rule fiercely for years. Though they failed to develop the resources of Mindanao, they long prevented the immigration of settlers from the crowded islands to the north. As they begin to accept education and to coöperate in the government, their intelligence and energy is proving a valuable asset. They number about 500,000.

How the Varied Peoples Live

In the mountain fastnesses dwell some 200,000 pagan peoples who have refused Christianity and civilization and have clung to their primitive ways of life. Many of these tribes belong to a Mongoloid stock related to that of the Christian Filipinos. They probably came to the islands first, and were driven inland by later arrivals. Best known of these tribes are the Igorots, Bontoks, and Ifugaos of the northern Luzon uplands. The Ifugaos have terraced the mountainsides, building 1,400 miles of high rock walls to retain their tiny fields, and bringing water through bamboo pipes to irrigate the rice on which they live. Some pagan tribes dig gold, copper, and iron from mines that are hundreds of years old, and fashion ornaments for trade. The Igorot custom of taking the heads of their enemies in tribal feuds was suppressed by the constabulary only a few decades ago. The men of these pagan tribes wear loin cloths and sometimes a shirt. The women wear a sarong, or *tapis*, and a jacket.

Pygmy Negritos—probably the original inhabitants of the archipelago—dwell in the remote forests. These small, shy, black people, with crispy hair and wide noses, live the most primitive existence, obtaining their food by hunting and fishing. They make their meager clothing from the inner bark of a tree.

and build lean-tos of sticks and grasses to shelter them on their wanderings. Though the pygmies are widely scattered among the islands, they probably number not more than 50,000.

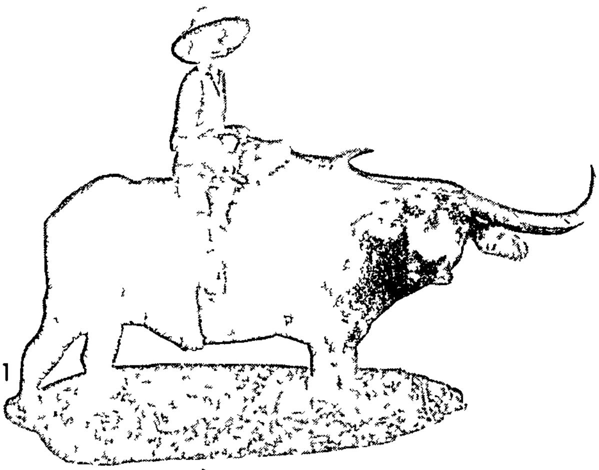
Few people other than Filipinos live in the country. The 150,000 Chinese wield more influence than their numbers would indicate, since they control most of the retail trade. Americans numbered fewer than 10,000 before the second World War and Spaniards perhaps half as many. Many Japanese had settled in the hemp-growing region around Davao on Mindanao before the war. Though *mestizos*, or persons of mixed racial ancestry, are relatively few, their importance in public affairs is evidenced by the fact that President Manuel Quezón was a Spanish mestizo and President Sergio Osmeña had Chinese blood.

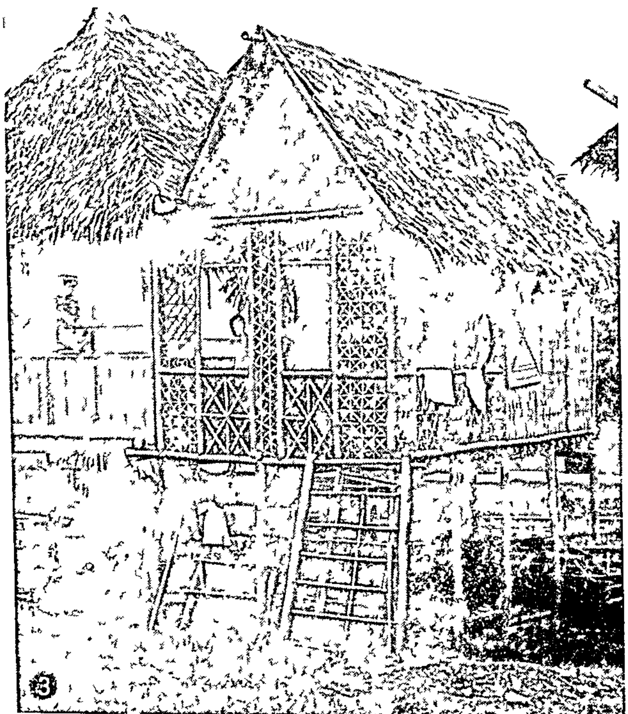
The volcanic islands of the Philippines extend north and south for more than 1,100 miles between the Pacific Ocean and the South China Sea. The islands themselves enclose a number of smaller seas. Much of the surface of the land consists of forest-covered mountains.

The Filipino Farming Family

The typical Filipino is a farmer, called a *tao*. He and his family are members of the Christian tribes who make up more than 90 per cent of the population of these fertile tropical islands. He lives in a village, or *barrio*, and cultivates an outlying rice or sugar field. In a land where nature produces such lavish growth, one might suppose that a farmer would fare well; but the tao has his troubles. He seldom owns his farm, and the landlord, or *cacique*, rarely provides land for a garden. So the family's diet consists almost wholly of rice, with fish from a near-by stream or bay. When his rice supply runs out before the new harvest, he must borrow from the landlord or the Chinese merchant. The excessive interest rates—often reaching as high as 100 per cent—make complete repayment almost impossible. Debt rides the farmer constantly, and he sells his crop at the low harvest price to meet his needs. Laws regulating interest rates have been passed. Farmers who grow coconuts for the copra market may own and live on their own small groves. They can set aside a garden patch for sweet potatoes (called *camotes*), tomatoes, onions, cabbages, and other vegetables, so their diet is more healthful than that of the tenant

FRIENDLY VIEWS OF THE PHILIPPINE WAY OF LIFE





1 A Filipino boy rides the carabao, the leading work animal of the islands. 2 This is one of the many attractive *Filipinas*, as the young women are called. 3 Airy homes like this are built of materials that grow free for the taking. The framework and the tall supporting stakes are made of bamboo stems, the walls, of split bamboo, and the roof, of nipa palm leaves. 4 The smile of this farmer, or *tao*, shows the happy, carefree nature for which the Filipinos are noted.

farmer. They depend upon a fluctuating market for their livelihood, however, and their copra does not bring top prices, since it is discolored by their primitive method of fire-drying (*see* Coconut).

The Filipino is apt, however, to have the carefree, pleasure-loving temperament typical of tropical folk, which enables him to rise above his troubles. He loves music and can spend a happy evening singing and strumming on his mandolin or guitar. He grooms a likely rooster for a cockfight, perhaps borrowing again to pay his bets if his bird loses. He revels in the color and gaiety of festivals held on church holidays, and delights in meetings and parades during political campaigns. The weekly market offers him and his wife a chance to visit their friends and to test their skill at trading, as well as an opportunity to enrich their diet by bartering for a chicken or a bunch of bananas

The Filipino family group find consolation and satisfaction in the teachings of the church, and look forward to a pilgrimage to the shrine of a miracle-working saint. The most famous of these is at Antipolo, near Manila, to which an image of Our Lady of Peace was brought from Acapulco, Mexico, in 1626.

In the villages, rows of straw-colored huts straggle along an unpaved street. Sleepy traffic stirs the dust or mud. It may be a heavy farm cart drawn by a lumbering water buffalo, or it may be a two-wheeled carriage, called a *carromata*, pulled by a small, thin pony. At the center of the village, an old Spanish church faces the plaza, or public square. Here a statue of José Rizal, or another hero, stands beneath an overhanging tree. A public market and a rickety grandstand for cockfights are near at hand. Though the other buildings may be weatherbeaten, the schoolhouse rises spick and span from a grassy yard planted with flowers and shrubs.

Thickets of bamboo trees and nipa palms supply free material for the Filipino's house, or nipa hut. Bamboo poles make the framework and the posts which lift the house two or three feet off the wet ground. Timbers are lashed together with rattan, so no nails are needed. Strips of split bamboo fashion floors with plenty of cracks that let the air circulate and

permit dust and refuse to drop to the ground. These floors give a bit under a man's weight, making a softer bed than would an American floor. Here the family sleeps with only a matting square for bedding. Nipa palm leaves thatch the steep, overhanging roof, and are woven with bamboo strips to make the walls. Window openings are closed at night with a nipa shutter to keep out evil spirits.

The hut of the poorer taos measures about six feet square. An extra lean-to may serve as a kitchen, where the housewife cooks the rice over a simple brazier in a pot that also does duty as the serving dish. If there is furniture, it will be a table and bench. Lacking chairs, the Filipino can squat for hours in comfort.

Better houses may have two rooms, panes made of flat shells in the shutters, and even board siding. Religious pictures or tinted photographs decorate the walls. If money can be found for their purchase, a clock ticks on the wall and a sewing machine stands by the window.

MORO SCHOOLBOYS ENJOY THEIR LIBRARY

These Moro boys of Jolo are getting a much broader education than did their warlike ancestors who went to school solely to learn the Koran. They study farming and industry besides academic subjects and take part in many sports.

Busy and Devoted Households

Close ties of affection and respect bind the Filipino family. Children learn to obey the head of the household, who directs the affairs of the family as a unit, rather than permitting its members to make individual plans. If the father and mother die, the eldest son or daughter takes over the management of the home. When grave decisions must be made, all but the smallest children may be consulted in a family conference. When the Angelus bell calls to evening prayer, the little children stop their play to come and kiss the hands of parents and elder sisters and brothers. Family loyalty and generous hospitality are the basis of the *pariente* system whereby needy kinfolk are welcomed into the home of a relative.

The tao wife usually controls the household finances and occupies a responsible position in the home in accordance with the Malayan tradition which made the woman the guardian of the rice seed. The well-to-do woman, who has been more influenced by Spanish customs, tends to hold a dependent and secondary position in the family. Under the Philippine constitution, women have the same suffrage rights as men. To vote, they must be able to read and write English, Spanish, or a native dialect.

The tao household rises at dawn and keeps busy until dark, except for siesta time during the intense heat of noon. The rice crop demands much work, and the whole family helps with weeding and harvesting. A small boy of five or six rides and guides the carabao, or water buffalo, as the huge beast pulls the plow or goes to a wallowing hole at noon to cool its

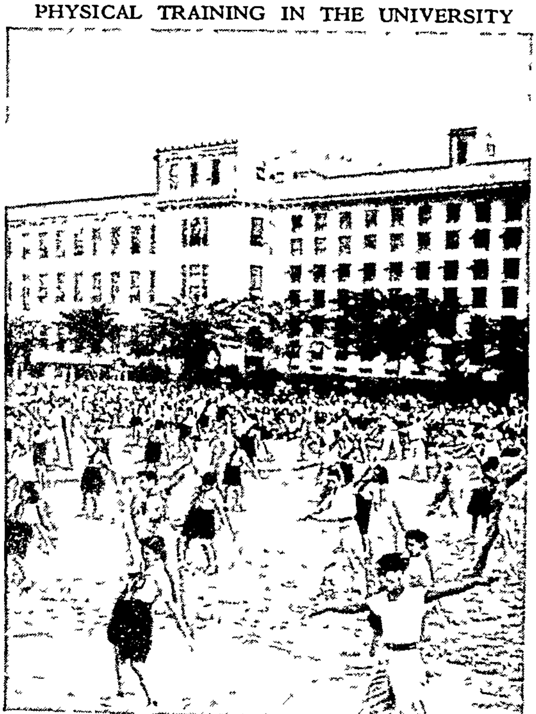
TO THE BEAT OF A DRUM, THE SCHOOL HEALTH PROGRAM MARCHES ON

Girls are taking their daily exercise at this typical rural school. This is part of a nation-wide health program that has helped the people to grow sturdier and taller. The average height of adult Filipinos has increased by five inches since 1898.

hairless hide. Children help tend the chickens or pigs that live under the house and serve as garbage collectors. Daughters go with their mothers to wash the clothes in a running stream. When no rice mill is available, they help to thresh the rice by pounding it in a hollow stump, then tossing it on a bamboo tray so the breeze will scatter the hulls.

Filipino children fly kites, swim, and play a variety of games—special ones of their own and the American sports they have adopted—enthusiastically. A favorite game called *sipa* uses a rattan ball that must be kicked about without dropping to the ground.

PHYSICAL TRAINING IN THE UNIVERSITY



This physical education demonstration on the campus of the University of the Philippines in Manila tells us that the health program continues through the advanced institutions as well as the elementary schools.

Typical Clothing of Country and City

Thin, cotton garments clothe the Filipinos. Tao men and boys wear light trousers and a jacket or shirt. A large, peaked palm-leaf hat shields them from the sun. Women and girls love bright prints, and often wear a wrapped skirt with a blouse of a different color. American styles are worn in the cities; and the children of the barrios are adopting these fashions through their school sewing classes. Filipinas have preserved their picturesque national costume called the *mestiza dress* for formal wear. The blouse has puffy sleeves and a wide, upstanding bertha of stiff, wiry cloth that forms a flattering frame for the face. It may be adorned with exquisite embroidery. The skirt is often made from a different fabric and cut with a train. At formal parties the men's costume, called the *barong Tagalog,* is a shirt of thin, wiry *piña* cloth made of pineapple fiber. It is open at the neck and hangs outside the black trousers.

The Influence of Christianity

During the Spanish period the village people had little contact with their rulers except through the church. The Spaniards made no attempt to spread education beyond a small group of leaders. They founded the University of Santo Tomas in 1611, but village schools were rare even at the close of their régime. They built few roads or hospitals. But their contribution of Christianity gave the Filipinos more than a satisfying faith. It provided them with a basis for understanding and accepting democracy and other Western ideals, and it served as a unifying force among peoples divided by distance and language. Today 70 per cent of the people are Roman Catholics. Another 20 per cent belong to the Philippine National Church, founded by dissenting Catholics under Bishop Gregorio Aglipay in 1902. Mohammedans number about half a million.

Improvements in Health and Education

The American régime had its most far-reaching effects on two aspects of life—health and popular education. When the Americans entered Manila they found it one of the foulest places in the Far East. Pure drinking water did not exist. Lepers were free to go where they wished, and great epidemics of smallpox, cholera, and bubonic plague came and went with little or no interference from the government.

The Americans instituted a public health program that not only eradicated the epidemics but also brought to the people information about health and nutrition. Hundreds of artesian wells were drilled, and simply because they provided pure water alone they cut the death rate in half. A successful campaign was waged against tuberculosis, with which, it was estimated, one-third of the Filipinos were infected. Through the Philippine Islands Anti-Tuberculosis Society, sanitariums were established and traveling clinics visited the more crowded parts of the islands. The spread of leprosy was checked by isolating the victims, notably in the Culion Leper Colony. This settlement, with its own churches, stores, and theater, held several thousand patients.

Before the health program started, four babies died in Manila for every five born. In 1940, 14 out of every 15 lived. During these years the Filipinos gained five inches in average height and became heavier and sturdier. The population doubled. Credit for these advancements goes both to the health program and to the lifting of the standard of living above that of any other Oriental people.

Cooperation between Americans and Filipinos brought an advancement in public education unequaled in any other country. United States soldiers served as teachers in order to open schools immediately. Then trained instructors were brought from the United States. As native teachers were trained, they took over the schools. Instruction in English made it more widely known than Tagalog, which was adopted as the national language in 1937. English and Spanish are official languages. Nearly all newspapers and magazines are printed in English.

The school curriculum developed according to the needs of the people. Household arts, agriculture,

and industrial skills were taught from the primary grades upward. Children learned the dignity of labor and the benefits that arise from doing needed tasks promptly and skillfully. Physical training and athletics were stressed.

Primary schools spread even to the pagan tribes, and elementary and secondary schools steadily increased. Adult classes were organized in 1936 to teach vocations and citizenship. The University of the Philippines in Manila, with an enrollment which at times reached 8,000, headed the state-supported institutions for higher education. Teacher-training, agricultural, and vocational colleges were scattered through the populous provinces.

Bombing, shelling, and wanton destruction by the Japanese damaged or completely demolished most of the Philippine schools and colleges. But a few months after liberation, the government began rebuilding the educational system on which the people's progress toward self-rule had been based.

The Filipinos' actual practise in self-government began with choosing their own municipal officers, and expanded to provincial and national elections. Year by year more civil service posts were placed in native hands. By the time the Commonwealth was established in 1935, self rule was familiar to most citizens and a stable government took office.

Agricultural Wealth of the Islands

Agriculture supplies at least three-fifths of the national income of the islands. So much land and labor was devoted in the past to crops for export, particularly sugar, that not enough rice, corn, vegetables, fruit, and livestock were raised to fill home needs. The balance is slowly being adjusted. Farms occupy about 20 per cent of the land, and rice grows on nearly half of this area. Corn is the second food crop, replacing rice on such islands as Cebu where the soils are too porous to be flooded for rice paddies.

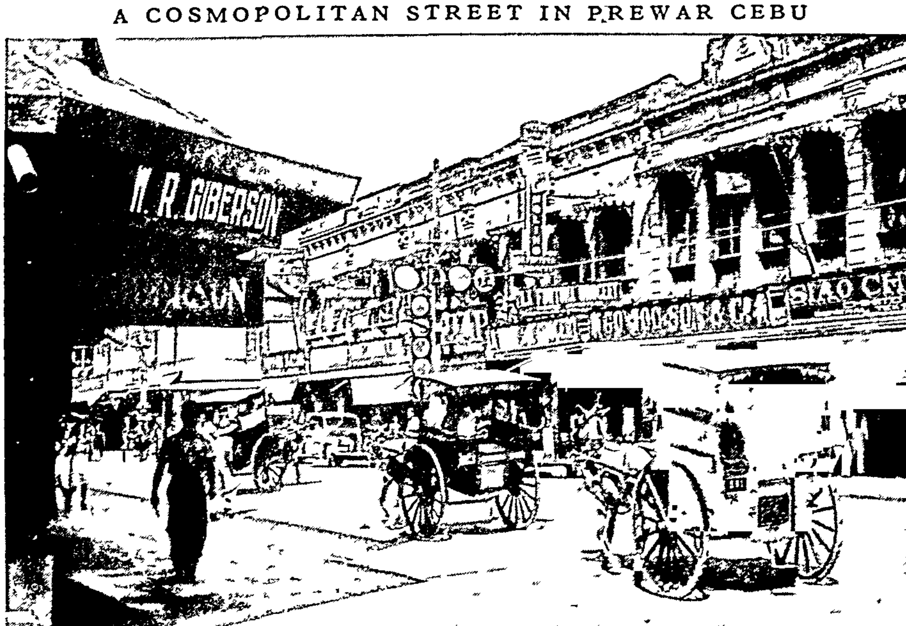
Coconut groves flourish on the sandy coastal plains, making the islands one of the world's chief exporters of coconut oil, copra, and related products. The abaca plant, which produces a strong, elastic, water-resistant fiber called Manila hemp, is another valuable export crop. The wet tropical climate of Mindanao and southern Luzon gives rise to high yields (see Hemp; Rope). Tobacco, one of the chief products under Spanish rule, has declined in acreage and value.

Sugar cane grows throughout the archipelago. The volcanic soils of central Luzon and Negros yield the largest harvests. Sugar became the chief export crop because it could be sold in the United States without duty. The prospect of losing this advantage after independence posed one of the leading economic problems of the islands. About 2,000,000 people were dependent upon sugar raising and processing for a livelihood, yet they were too remote from world markets for open competition. The United States Congress set up a system of gradually declining duty-free import quotas to give the Filipinos time to adjust their economy, and to learn to grow new, varied and more profitable crops.

Changes in crops or improvements in farming methods are difficult to bring about in the overcrowded sections of the islands. The conservative landowners and the untrained share croppers alike tend to cling to the crops and methods they know. On Mindanao, however, many stretches of land are undeveloped—even unexplored. The Philippine government plans to use this frontier country as a laboratory for developing new crops and improved farming methods. The National Land Resettlement Administration was established by the Commonwealth government in 1939 to aid tenant farmers from the north to get small farms of their own in Mindanao's fertile valleys, where they can raise cash crops as well as the food they need for a better diet. Cotton, rubber, pineapples, ramie fiber, cinchona, and lambang or tung nut have been successfully grown there. Before the second World War American firms had established pineapple and rubber plantations and pineapple canneries on Northern Mindanao.

To conserve the vast natural resources of the archipelago for its own people, laws provided that public land may be leased and private land purchased only by Philippine or American citizens and corporations. Concessions or leases are limited to 25 years

A COSMOPOLITAN STREET IN PREWAR CEBU



Signs in many languages reflect the mixed population of this Pacific port city. The two-wheeled carts, called carromatas or tartanillas, serve as slow but inexpensive taxicabs.

MILLING CANE AT A PHILIPPINE SUGAR CENTRAL

A cataract of sweet juice gushes from the sugar cane as it passes under the mill's knives and rollers. A belt carries away the crushed cane (bagasse) to be stored or to be used as fuel.

nation owns the wooded land and regulates its leasing for lumbering. Only the fine cabinet woods have been exported to the United States. White and red lauan and tangile are marketed as Philippine mahogany.

Mining was making rapid progress before the war, and gold stood second among exports. It came mainly from deposits in the region of Baguio on Luzon which were mined in primitive fashion before the Spaniards arrived. Iron is found in Luzon, Samar, and eastern Mindanao. Other mineral reserves include copper, manganese, chromite, lead, zinc, and coal unsuited for coking.

Philippine industries are mainly those needed to process the chief crops: sugar centrals and refineries, rice mills, hemp stripping plants, cigar and cigarette factories, plants for shredding coconut or pressing coconut oil, and sawmills. A few, such as shoe factories, soft-drink plants, bakeries, cement plants, and canning factories, serve the local markets. Home industries produce export goods. Embroideries are the chief of these. Contractors import fine cotton cloth, stamp it with designs, and distribute it to the homes, where women do the delicate needlework. Girls learn embroidering in the schools, which also sell their products. Home weavers make fabrics and hats from native fibers.

Many things sold in the stores are imported, chiefly from the United States. The leading imports are iron and steel goods, automobiles, tires, electrical machinery, petroleum products, cotton goods, chemicals, meat and dairy products, flour and tobacco products.

Most of the Philippines' foreign trade is carried on with the United States. In normal times the American

and may be renewed for another 25 years. No corporation may acquire more than 2,500 acres.

Lumbering, Mining, and Industrial Growth

The forests which cover nearly 60 per cent of the islands promise profitable future development. The

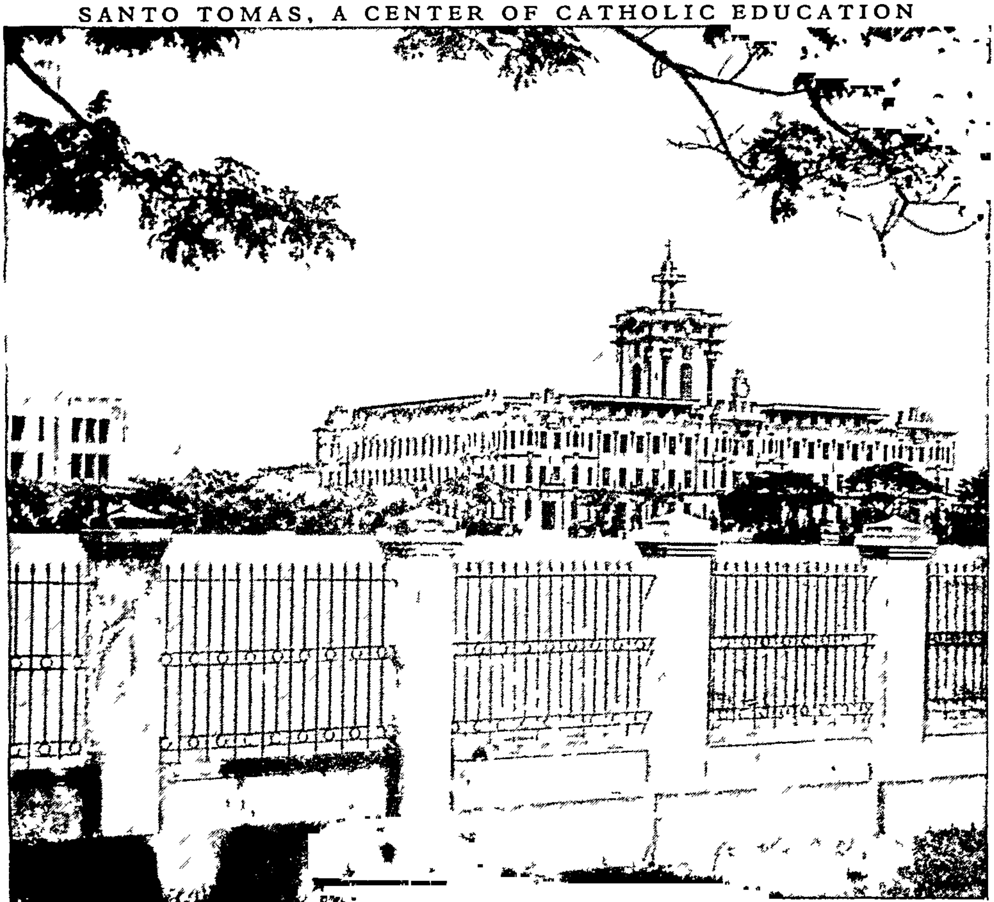
WHERE COCONUTS GIVE UP THEIR VALUABLE OIL

These plantation workers are stripping coconuts of their thick husks and dropping the egg-shaped kernels on a moving belt. The coconut industry is one of the largest in the islands.

people get 83 per cent of the islands' exports and send out more than three-quarters of their imports.

Industry is centered largely in Manila, the largest city, chief port, and long the capital (*see* Manila). Large ships and transpacific planes call here. The country has only about 1,000 miles of railways, nearly all linking Manila with other parts of Luzon. Inter-island cutters and freighters stop at several smaller distribution centers, such as Cebu on Cebu Island; Iloilo, on Panay; Zamboanga and Davao on Mindanao; and Jolo, the Mohammedan capital of Sulu. Baguio in the Luzon mountains was the American summer capital. In 1948 the capital was officially moved from Manila to Quezon City, a suburb about ten miles northeast of Manila. But the actual transfer awaited new buildings.

SANTO TOMAS, A CENTER OF CATHOLIC EDUCATION



Founded by Dominicans in 1611, the University of Santo Tomas, in Manila, has trained many Filipino leaders. During the Japanese occupation, American citizens were interned in the building shown here.

History

The Philippines were discovered by Ferdinand Magellan, who entered Cebu harbor in April 1521. During a skirmish with the natives he was killed, but his ships went on to make the first journey around the world (*see* Magellan). In 1542 Lopez de Villalobos attempted to conquer the islands and named them "Filipinas" in honor of Prince Philip of Spain. Spanish colonizing began in 1565 when Miguel Lopez de Legaspi arrived from Mexico with 400 settlers and a group of friars. He founded the first Spanish settlement on Cebu. Before his death in 1572 he had conquered the islands and explored a large part of the interior. Spain was mainly interested in Christianizing the islands, and the religious motive dominated its policy for three centuries. But when it lost its colonies in the Americas early in the 19th century, the Philippines were the richest possessions left, and the spirit of colonial exploitation grew.

Filipino resentment against the oppression and extortion of the Spaniards was fanned into open revolt by the writings of the patriot José Rizal. His execution on Dec. 20, 1896, spurred on the insurrection movement. This had come into the open earlier in the year under the leadership of Emilio Aguinaldo. Two years later the United States went to war with Spain (*see* Spanish-American War). On May 1, 1898, Commodore Dewey disabled the Spanish fleet in Manila Bay (*see* Dewey, George). By August 13 the Americans had occupied the city, and on April 11, 1899 the islands passed into the hands of the United States by virtue of the Treaty of Paris, after a payment of $20,000,000 to Spain. In the meantime Aguinaldo had proclaimed the Philippines independent and himself their president. His army now attacked the Americans. Hundreds of engagements followed until his capture on March 23, 1901. On July 4, 1901 a government was established with William H. Taft, later president of the United States, as governor general.

Progress toward Independence

American political parties took opposite stands on the Philippines. A Republican president—McKinley—was in office when they were acquired, and the Democrats condemned the action as imperialistic. As the years passed, Democratic administrations tended to give the Filipinos an increasing share in their government and to call for early independence. Republican policies favored longer political apprenticeship.

In 1916 a large measure of self-government was granted when the United States Congress passed the Jones Act, providing for a legislature in which both houses were elected by popular vote. The date for independence was set at July 4, 1946 by the Tydings-McDuffie Act of 1934, which created a Common-

WHEN THE DREADED TYPHOON STRIKES

Here we see Manila's streets flooded by the torrential rains that accompany the autumn typhoon, or baguio. People are wading knee deep in the water, busses are stalled, and a horse has fallen in the shafts of a carromata.

wealth government. The constitution of the Philippines, ratified by the vote of the people on May 14, 1935, included an ordinance governing relations with the United States during the Commonwealth. It provided that the United States was to retain control of defense, foreign relations, and major public finances.

The government constituted for this "daughter republic" resembles that of the mother country, and is based on the principle of the separation of powers among the executive, legislative, and judicial branches. Each of the 49 provinces has a provincial governor and a provincial board; each town has a mayor and municipal council, who are elected by popular vote. Exceptions are the non-Christian and sparsely populated provinces governed under the supervision of the department of the interior.

Japanese Conquest and Liberation

The Filipinos were not permitted to carry through their preparation for statehood in peace. Their islands lay in the path of the Japanese drive for the conquest of the Far East. In December 1941, a few hours after the Pearl Harbor raid, Japan attacked the Philippines. Despite the gallant defense by Commonwealth troops and United States forces, under the leadership of Gen. Douglas MacArthur, the islands had fallen under Japanese control by May 6, 1942 (*see* World War, Second; MacArthur). President Manuel Quezón escaped to set up a government in exile in the United States. Sergio Osmeña succeeded to the presidency upon Quezón's death in 1944.

Meanwhile fiercely loyal Filipino guerrillas continued to harass the Japanese occupation forces. They were aided by Americans who had hidden in the mountains in 1942, and by others — especially counter-intelligence men with radio equipment—who were smuggled in by boat or airplane.

On Oct. 20, 1944, General MacArthur's liberating army landed on Leyte, to begin the reconquest of the islands. Japanese resistance was particularly bitter on Leyte and at the siege of Manila. Jungle and mountains also hindered progress, and enemy troops were still fighting in the highlands when the war ended.

On July 4, 1946, the Commonwealth became the Republic of the Philippines. Its first president was Manuel A. Roxas. The republic faced a giant task. The war had ruined business and destroyed equipment in mines, industries, and on farms and plantations. Lawless gangs preyed on devastated cities. Armed, landless peasants, called *Hukbalahaps*, or *Huks*, demanded division of large estates.

Communists gained positions of leadership in the Huk bands. The army was unable to break up their looting and guerrilla warfare in Central Luzon. In 1951 President Elpidio Quirino's government started a resettlement program for the Huks in Mindanao. Men who surrendered were offered 25 acres, a house, tools, and work animals

The United States government worked closely with the young republic. A treaty provided that imports from the islands would be duty free until 1954 and carry reduced rates for 20 years. An agreement in 1947 permitted the United States to retain military bases in the islands for 99 years. A 1947 plebiscite amended the constitution to grant American investors equal rights with Filipinos in acquiring and developing natural resources.

In the first five years after the war, the United States allocated some 2 billion dollars to the islands. This covered grants-in-aid, war damage claims, reconstruction work, and military expenses. To get long-term help from the United States, the republic enacted a minimum-wage law and other reforms In 1952 it signed a mutual defense treaty with the United States, and in 1954 it asked that nation to extend the trade agreement into 1955. The Huk movement receded in 1954 with the surrender of its leader.

PHILIS'TINES. When the Israelites entered the Promised Land, their greatest enemy proved to be the Philistines. They were the strongest of the Canaanite tribes and they gave the whole country the name of Palestine (land of the Philistines). Their group of five cities — Gaza, Ashkelon (Ascalon), Ashdod, Gath, and Ekron—formed a small district on the Mediterranean coast southwest of Israel. It is possible that they came originally from some Minoan center of culture in Asia Minor. Their religion was an idolatrous worship centering about Dagon, a god represented as part man, part fish. Like the Semitic Phoenicians, to the north of Israel, they were a seafaring people; but while the Phoenicians confined themselves to peaceful pursuits, the Philistines continually harassed the Israelites and sought by conquest to extend their territory to the east. They finally fell before the great conquerors who one after another swept Palestine—the Assyrians, Babylonians, Persians, Ptolemies of Egypt, Seleucids, and the Romans. The name "Philistine" is today used as a term of contempt for narrow-minded persons.

PHILOSOPHY. The word philosophy comes from the Greek *philein*, meaning "to love," and *sophia*, meaning "wisdom." Hence "philosopher" originally meant "a lover of wisdom." The word has since come to have many meanings. But in its full sense it is only man thinking — thinking about generalities rather than particulars, trying to see all time and existence as a whole.

Today, study of the physical world and of man is divided into many departments. But at first there were no such separate departments of study. The early philosophers studied subjects which today would be called astronomy, physics, or natural history, as well as logic, ethics, and metaphysics, which are now called philosophy.

When we separate one particular aspect of the world or of society and study that by itself, we usually call this a science. This is especially true if we study something which we can count or measure exactly. On the other hand if we aim not to get a precise statement of one particular part but instead try to find the meaning of the whole, we call the study philosophy. Philosophy has also a moral implication. Thus we often hear, "He took it philosophically," or "He is a real philosopher." Such statements mean that the person's feelings are properly controlled by reason.

In a narrower and more technical sense, philosophy means *metaphysics*. This is the discussion of various abstract questions such as the nature of being and the great first causes of things. The sciences use such words as space, time, matter, and causality, without examining the meanings of the words. Metaphysics asks such questions as: What are space and time? What is meant by a "thing," and how does it differ from an "idea"? Is *good* a matter of opinion only, or does it have some existence outside of the mind? Metaphysics inquires into the cause, the substance, and the outcome of all things.

When a person is judging right and wrong, he is using the branch of philosophy we call *ethics*. Some consider that we can decide such questions by reason; others believe that right and wrong are matters of feeling. When we ask what standard shall we actually use, some hold that the most important thing is whether our conduct produces happiness; others feel that the test is whether it enlarges our life by making us more perfect. Those of the first school are called *hedonists*, from the Greek word that means "pleasure or happiness"; those of the other school have been called by various names but most frequently *idealists*.

Hedonists are further subdivided according to whether they emphasize the happiness of the person himself or the happiness of others as the true test. The first are called *egoists*, or sometimes *epicureans*, because the Greek philosopher Epicurus was the founder of a school which held this doctrine. The second group are sometimes called *altruists*. One particular group of altruists who were active in England in the early part of the 19th century are called *utilitarians*, or *Benthamites* after the English philosopher Jeremy Bentham (1748–1832). Their maxim was "the greatest good of the greatest number."

"Things" and "Thoughts"

Our knowledge of nature and our views about life may be regarded as having two parts. On the one hand we see or hear or touch. On the other, we have to arrange or organize in our minds our ideas about what we see and hear and touch.

Some philosophers have thought that the particular things we see and hear and touch are the more important. They then aim to form some general principles from examining these particular facts. This method is called *induction*, and the philosophers who use it are called *empiricists*. The word means that they rely upon experience.

On the other hand, some philosophers have been most impressed by the fact that if we can find a general law, we can then proceed to understand or judge particular facts by bringing them under this general law. To begin with a general law or rule and proceed to particular cases is called *deduction*, and the philosophers who have tried to understand the universe by first grasping its general nature are called *rationalists*.

A newer school, called *pragmatism*, has still another method of approaching these problems. This school believes that *value in use* is the real test of the truth and meaning of any idea. When anything is asserted as truth, the pragmatist asks, "What sensible difference will it make to anybody, whether we accept or reject this proposition?"

Pragmatism was first formulated by C. S. Peirce, an American scientist. William James developed and popularized it and became the leading pragmatist.

It is very evident that there are a great many separate things, such as rocks and trees and persons; it also seems clear that our body is one thing and our mind is another. On the other hand all these separate things are in some sense related to one another. That is, they go together to form a whole. A man's mind and body together make up one person. Every part of the universe is probably affected by every other part. Those philosophers who have emphasized the unity of the world are called *monists*. Those who consider the distinctions and separateness between things most important are called *pluralists*.

Materialism and Idealism

Perhaps the simplest distinction in our world is that between persons and things. Persons are alive and think and move of their own will. Things do not move unless they are acted upon by some other thing or by a person. Some philosophers have thought of the world as though it were all made up of things, or to use the technical term, of *matter*. They have been called *materialists*. Others have believed that the world is to be regarded rather as though it were to be understood also as mind. They have been called *idealists*.

Besides metaphysics and ethics, there are two other important divisions of philosophy. *Logic* is the science

of thinking and of classifying arguments into good and bad (*see* Logic). *Aesthetics* is the science of the beautiful, in its broad sense—including the sublime, comic, tragic, pathetic, and ugly (*see* Arts, The).

Leaders in Developing Philosophy

The first people to think systematically about the great questions of the universe and give philosophy a meaning were the ancient Greeks. Famous Greek philosophers include Thales, Heraclitus, Democritus, Aristippus, Socrates, Plato, Aristotle, Pythagoras, Epicurus, Zeno, and Diogenes (*see* Aristotle; Epictetus; Plato; Pythagoras; Socrates). The Romans borrowed their philosophy from the Greeks. Lucretius, Cicero, Marcus Aurelius, Epictetus, Plotinus, and Boethius all carried on the Greek tradition in some form (*see* Cicero; Marcus Aurelius Antoninus).

During the Middle Ages, philosophers worked to harmonize the doctrines of Aristotle with the teachings of the church. Their thinking, known as Scholasticism, was developed by such famous medieval philosophers as Duns Scotus, Thomas Aquinas, Peter Lombard, Abelard, Anselm (*see* Abelard).

The Revival of Learning impelled men to strike out into new paths of philosophic thinking. Francis Bacon, the great English philosopher, laid the foundations of modern empiricism. The Frenchman Descartes established principles which underlie modern rationalism (*see* Bacon, Lord Francis).

During the last three centuries important contributions to philosophic progress have been made in each of the leading nations of Europe, as well as in the United States. The outstanding names in England are Thomas Hobbes, John Locke, George Berkeley, David Hume, Dugald Stewart, Jeremy Bentham, John Stuart Mill, Herbert Spencer, T. H. Green, and Bertrand Russell. Germany produced such epochal thinkers as Leibnitz, Kant, Fichte, Hegel, Schelling, Schopenhauer, Nietzsche, and Herbart. France is represented by Malebranche, Condillac, Diderot, Pascal, Rousseau, Voltaire, Comte, Cousin, Henri Bergson, and Jacques Maritain. Holland produced the great Spinoza. The United States is chiefly known by the work of Jonathan Edwards, Ralph Waldo Emerson, William James, John Dewey, and the Spanish-born George Santayana. (*See* Emerson; Rousseau; Voltaire.)

PHLOX. A favorite garden and wild flower is the phlox. The bright colors of the blossoms—blue, purple, pink, crimson, salmon, and white—gave the flower its name, the Greek word for "flame."

The wild blue phlox, or sweet William, grows in the spring in moist woods from Canada to the Gulf coast. It is an erect plant, one to two feet tall, with flowers about an inch across. The western sweet William has pink blossoms. Prairie phlox, a large plant with pink or purple flowers, grows on the open prairies in the summer. Ground or moss pink has short, spreading stems that form a compact ground cover like moss. The small delicate blossoms stand two to six inches above the ground. The leaves are thick and needlelike. Alpine phlox, also a creeping plant, grows on rocky mountain slopes.

The garden phloxes are annuals or perennials. Both are easily cultivated, but require fertile soil, and plenty of moisture and sunshine. With proper care they bloom profusely throughout the summer and fall. They may be grown from seed, but usually new plants are reared from the vigorous young shoots on the outside of the clump. Old clumps should be divided and transplanted every year or two. This is done in the fall when growth has stopped.

A CLUMP OF GARDEN PHLOXES

The garden phloxes are colorful and showy plants that bloom all summer. Notice the salver-form flowers, characteristic of both the wild and garden phloxes.

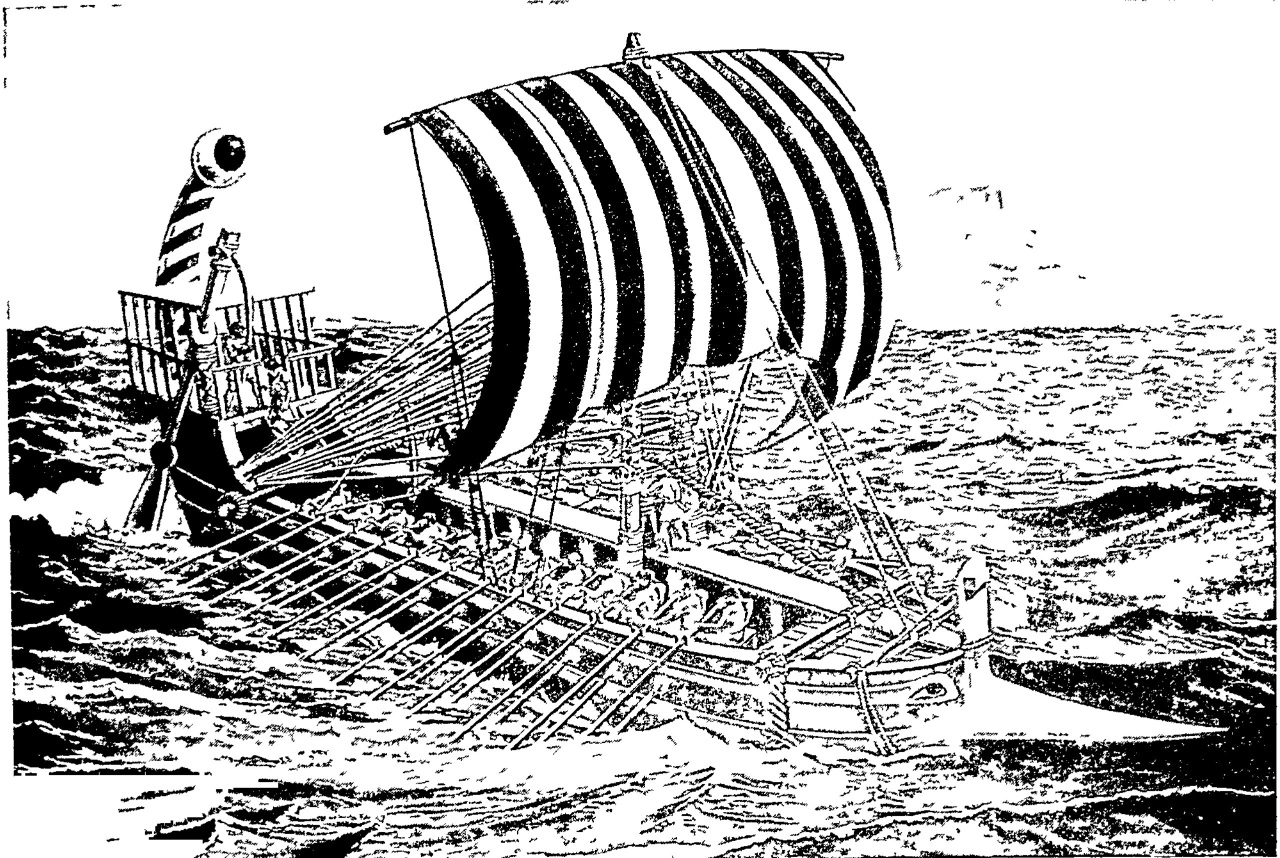
The phloxes belong to the genus *Phlox* of the family *Polemoniaceae*. Nearly 50 species are native to North America. The blossoms grow in clusters, called *cymes*, at the top of the stem. The flower has a calyx of five slender, pointed sepals. The corolla is a narrow tube, opening out to five salver-form (flat-spreading) petals.

The scientific name of the sweet William, *Phlox divaricata;* of western sweet William, *P. longifolia;* prairie phlox, *P. pilosa;* moss pink, *P. subulata;* Alpine phlox, *P. Douglasii.* Most garden annuals are varieties of *Phlox Drummondii*, native to Texas. Perennials are varieties primarily of *P. paniculata* and *P. maculata.* (For illustration in color, *see* Flowers.)

PHOENICIANS (*fē-nĭsh'ănz*). More than 2,000 years before Columbus' day, Phoenician mariners sailed to Mediterranean and southwestern European ports. People came to buy their wares, for the Phoenicians were the great merchants of ancient times. They sold rich treasures from many lands—perfumes and spices from the Far East; fine linen from Egypt; wool from Arabia; vessels of brass, silver, and gold made by their own skilled artisans; ornaments of carved ivory; and emeralds, coral, agate, and amber.

These Phoenicians (the Canaanites or Sidonians of the Bible) were Semitic people. Their country was a narrow strip of the Syrian coast about 200 miles long and about 20 miles wide. It was a land of pastures, orchards, and vineyards, but so scanty that the Phoenicians were forced to sea for a living. Surpassing their teachers the Egyptians, they became the most skillful shipbuilders and navigators of their

PHOENICIANS BRINGING HOME TIN FROM BRITAIN



With a full wind helping them, these Phoenician mariners are rowing their seagoing galley homeward through the Strait of Gibraltar. Today nobody knows exactly how such a galley looked, but the picture shows the known details. Notice how heavy ropes were used to strengthen the ship—especially the fore-and-aft hogging stay. This checked bending as the galley passed over waves.

time. They worked the silver mines of Spain, passed through the Strait of Gibraltar, and founded the city of Cadiz on the western coast. They sailed to the British Isles for tin, and may have even passed around southern Africa. They founded many colonies, the greatest being Carthage. This city grew into a great empire and rival of Rome (*see* Carthage).

The Phoenicians began to develop as a great seafaring, manufacturing, and trading nation when the Cretans—the first masters of the Mediterranean—were overthrown by the Greeks (*see* Aegean Civilization). Not only did they take the fine wares of the Eastern nations to the Western barbarians, but they became skilled in making such wares themselves—especially metalwork, glass, and cloth. From a shellfish, the *murex*, they obtained a crimson dye, called Tyrian purple. This was so costly that only kings and rich nobles could afford garments dyed with it. Purple became the symbol of kingly rank and great wealth.

But their most useful service was spreading the alphabet. The alphabet had apparently been invented by another Semitic people (*see* Alphabet); but Phoenician traders, who used it to keep their accounts, played an important part in carrying it to the other peoples of the Mediterranean.

The Wealth of Tyre and Sidon

There were two great cities of Phoenicia—Sidon the center of the glass industry, and Tyre the center of the purple industry. In the middle of the 10th century B.C. Tyre assumed the leadership of all Phoenicia. Friendly relations were established with the Hebrews, and King Solomon sent to King Hiram of Tyre not only for materials but for skilled workmen to build the temple. There were none with "skill to hew timber like unto the Sidonians."

In the 6th century the Phoenicians supplied the great fleets with which Darius and Xerxes attacked Greece. Usually they submitted readily to foreign conquerors and paid tribute. In return, they were allowed to pursue their commercial enterprises as they liked. Alexander the Great in 333 B.C. took Tyre, after one of the greatest sieges of history. In 64 B.C. Phoenicia came under the control of the Romans, and under their rule the native language and institutions soon became extinct.

The chief divinities of the Phoenician religion were the god Baal and the goddess Astarte, or Astoreth. In times of great distress human sacrifices were offered to the god Moloch.

Today the small island on which Tyre once stood is connected with the mainland by a broad tongue of land. It grew out of the mole built during Alexander's siege. The city site is occupied by Sur (population, 1946 census, 9,455). Luxuriant fruit gardens flourish where Sidon once stood. They furnish the main support of the modern city of Saida (17,739).

PHOENIX, ARIZ. One of the fastest-growing cities in America is Phoenix, the capital of Arizona. A favorable geographic location has contributed greatly to the city's rapid growth. Lying almost midway between El Paso, Tex., and Los Angeles, it is an important trade and transportation center for the entire Southwest region. It is also the shipping point for products of the fertile Salt River valley.

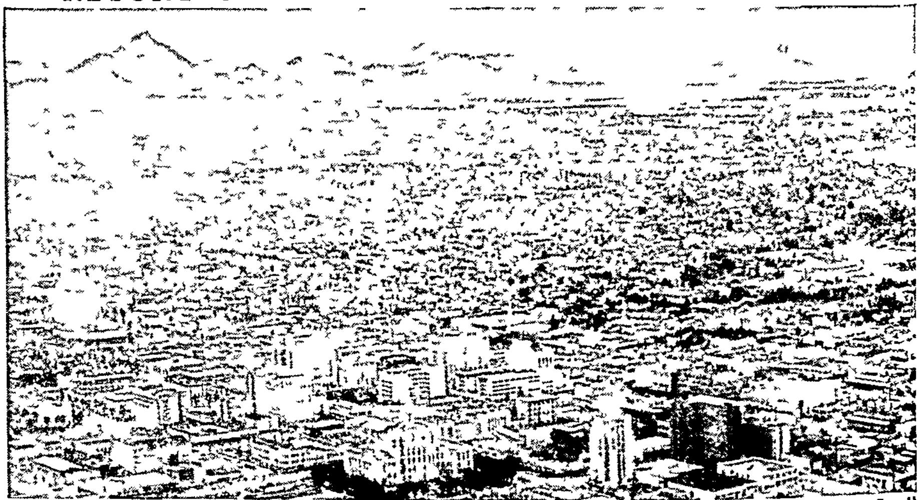
But the chief reason for the city's prosperity is its healthful climate. It is especially noted for its clear, dry air and many sunny days. During the winter months the average temperature of Phoenix is in the 70's and rainfall is rare. This pleasant climate has made Phoenix one of the nation's leading winter resorts. Entertaining its guests in the gay, informal manner of the "Old West" has become the city's biggest business.

Tourists are also attracted by the city's scenery and many recreational facilities. Residential streets are lined with palms, green lawns, and semitropical flowers. On the outskirts of Phoenix are picturesque ranches and luxurious resort hotels. Near by is South Mountain Park, one of the largest city parks in the United States. It covers 14,000 acres along the slopes of the Salt River Mountains. Other points of interest are the State Capitol and the Phoenix Indian School.

Phoenix lies in the center of the huge saucer-shaped valley of the Salt River. This region was once only sunburned desertland. But an irrigation system, based on dams on the Salt River, has made it a rich agricultural area of some 400,000 acres. Tons of vegetables, citrus fruits, and melons are grown here the year round and trucked into Phoenix for shipment all over the United States.

The city's name was suggested by ruins of prehistoric mounds and irrigation ditches in the valley. An early settler proposed the name "Phoenix," for the fabled Egyptian bird that could rise from cremation and live again. Incorporated as a city in 1881, Phoenix adopted a council-manager government in 1949. Population (1950 census), 106,818.

RESORT CITY IN THE "VALLEY OF THE SUN"



Phoenix, the capital of Arizona, lies in the Salt River valley, often called the "Valley of the Sun." Here it rains less than eight inches a year, but irrigation has made the valley highly productive. The aerial picture shows the Phoenix Range rising from the valley floor to the north of the city.

PHONOGRAPH. If you cannot go to hear a symphony orchestra or your favorite jazz band, you can do almost as well by listening to them on a phonograph recording. Moreover, you can play your recording again and again. Once the voice of a famous singer or the music of a soloist or orchestra is captured on a record, you can preserve it indefinitely.

Inventors have made this possible by harnessing the properties of sound. Sounds such as speech, singing, and instrumental music are caused by vibrations of air (*see* Sound). To reproduce sounds as the phonograph does, we must "catch" the vibrations in some way on a record. Then we can use the record to reproduce the vibrations on a phonograph or any other type of record player whenever we like.

How Sounds Are Recorded

The simplest system of making a record catches the air vibrations in the mouthpiece of a tube. The other end of the tube bears a flexible disk and a cutting tool. The vibrations of sound make the disk flutter, and the tool moves with the disk Meanwhile, a plate of soft, waxy material is revolving beneath the tool The surface of the plate has a continuous groove that spirals around from the outer edge almost to the center. The point of the tool rests in the groove and marks it from side to side as the plate revolves. Thus the plate catches a record of the sounds poured into the tube.

To reproduce these same sounds, the process is reversed. The cutting tool is removed and a needle is put in its place. As the record revolves, the needle follows the markings in the groove and causes the disk to vibrate. This vibrating motion of the disk moves the air in the tube and produces sounds.

Early and Modern Recording Devices

Of course, this is a simplified description of a modern phonograph. But the first phonograph was just as simple as this. It was invented by Thomas A. Edison in 1876 and patented in 1877.

This "talking machine" had a tube with a fine membrane stretched over one end and a steel needle on the outside of the membrane. For his record, Edison used a wax cylinder. The cylinder was cut with a spiral groove from end to end and covered with tin foil. A driving device kept the cylinder spinning and also moved it slowly past the steel needle. As some-

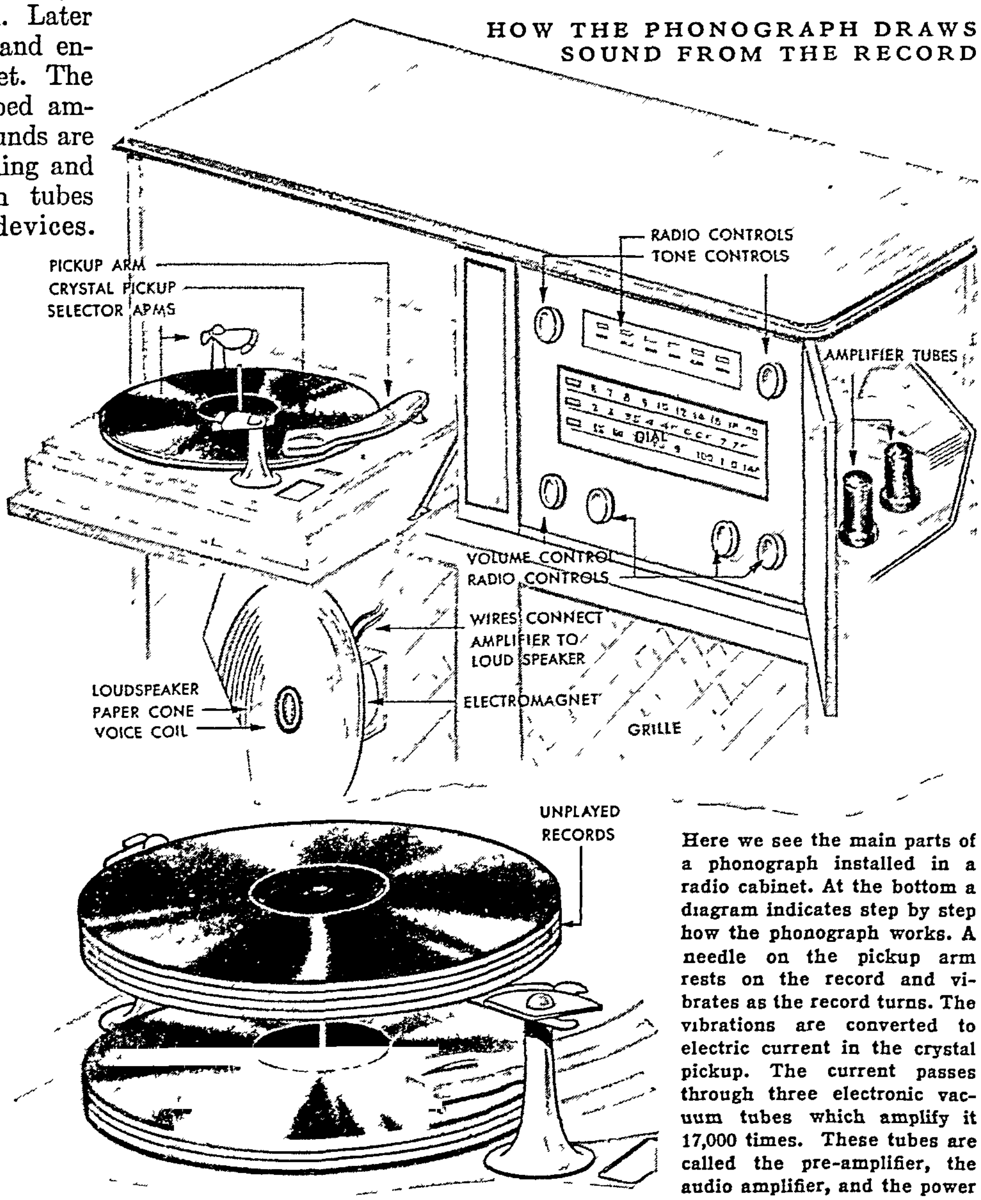
one spoke into the tube, the sound vibrations moved the needle, and the needle pressed the tin foil into the groove with varying force. Thus the foil received a record of the sound. A refined version of this device is still used in the mechanical type of dictating machine (*see* Dictating Machine). Emile Berliner invented the flat, disk type of record in 1887.

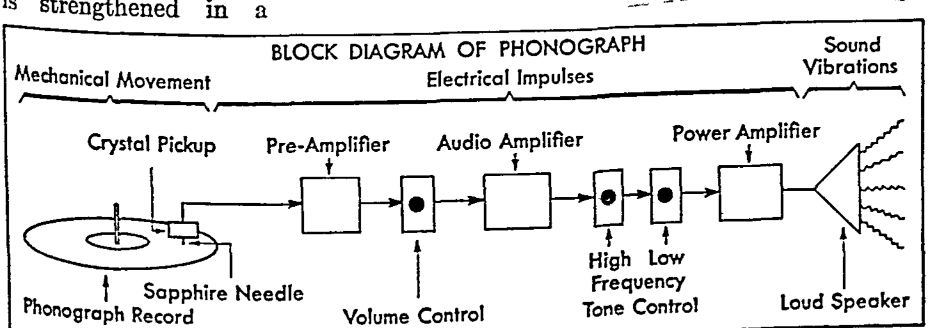
Some of the sounds recorded and reproduced by these early methods were faint, and a large horn was used to make them heard. Later the horn was curled up and enclosed in a wooden cabinet. The sides of the cabinet helped amplify the sound. Now sounds are amplified both for recording and for playing by vacuum tubes and electromagnetic devices.

The modern recording method converts the mechanical sound waves into a series of electric currents. These in turn operate the cutting tool on the waxy disk. First the sound is directed into a microphone. This contains a vibrating metal disk called a *diaphragm*. Carbon grains are in contact with the diaphragm, and an electric current passes through them. As sound hits the diaphragm, the vibrations alternately pass through and separate the carbon particles. When the carbon particles are closely packed, they conduct the current readily. When the particles fall apart, the spaces between them offer resistance to the flow of current. This alternate conducting and resisting causes the current to fluctuate in strength. The fluctuating current is strengthened in a special vacuum tube called an *amplifier*. The amplified current then goes to a magnet with an attached cutting tool. The entire action of the diaphragm and carbon particles resembles that of your telephone transmitter (*see* Telephone).

Another method uses the vibrations of the diaphragm to generate electric current. Instead of carbon particles, crystals of Rochelle salts are attached to the diaphragm (*see in* Fact-Index, Rochelle salt).

HOW THE PHONOGRAPH DRAWS SOUND FROM THE RECORD





Here we see the main parts of a phonograph installed in a radio cabinet. At the bottom a diagram indicates step by step how the phonograph works. A needle on the pickup arm rests on the record and vibrates as the record turns. The vibrations are converted to electric current in the crystal pickup. The current passes through three electronic vacuum tubes which amplify it 17,000 times. These tubes are called the pre-amplifier, the audio amplifier, and the power amplifier. The current can be adjusted for volume and tone along the way, and it is converted to sound in the loudspeaker. Note how unplayed records are supported on the selector arms. As one record finishes, another drops directly over it until the whole stack is played. The pickup arm automatically moves away and returns, adjusting itself to the height of the stack of records on the turntable.

These crystals produce electric current when pressure is applied to them. The vibrating diaphragm furnishes the pressure, and the crystals set up tiny, fluctuating currents. These are amplified and sent to the magnet that operates the cutting tool.

The plate cut by the recording tool is used to make a "matrix" die. From this the records are made. The die is a reverse image of the original plate, with ridges instead of grooves. It is pressed onto blank record plates, and each record then becomes a replica of the original.

Formerly all records were made of shellac. But shellac is brittle and the records broke easily. Now most records are made of a mixture of shellac and clay, paper coated with shellac, glass, or aluminum. "Unbreakable" records are made of vinyl plastic.

Records are made to be played at one of three turntable speeds—78, $33\frac{1}{3}$, or 45 revolutions per minute. *The older, "standard" speed is 78 r.p.m. For long* classical works this speed has been virtually superseded since 1948 by $33\frac{1}{3}$-r.p.m. disks. A 12-inch "LP" (long-playing) record provides up to $32\frac{1}{2}$ minutes of music on one side. Ten-inch "LP's" are frequently used for collections of popular or classical pieces; one such record is equivalent to a standard album of six to twelve sides. (Radio transcriptions are made on $33\frac{1}{3}$-r.p.m. disks that play for 35 minutes.) Many single popular pieces and short classical works are recorded at 45 r.p.m. These seven-inch disks play for as long as eight minutes. Record players that play at all three speeds find a wide market.

Playing the Record

Sound is drawn from a phonograph record by the same type of process that locks sound in the record. The record revolves on a turntable, and the needle is held in the record groove by a *pickup arm.* You can see both of these in the picture on the preceding page. The base of the needle presses on crystals of Rochelle salts held in the pickup arm. The crystals set up an electric current that fluctuates in step with the vibrations of the needle. The current is amplified and sent to a magnet, called a *voice coil,* set in a paper cone inside the loud-speaker. The voice coil pushes and pulls the cone and sets up the mechanical vibrations that we hear as sound.

After the second World War, a strong demand arose for high-fidelity ("hi-fi") record-playing equipment. This equipment seeks to reproduce music exactly as it is recorded. The human ear detects sound from about 16 to 20,000 cycles, or vibrations, per second, and most of this range (up to 15,000 cycles) is recorded. Good conventional equipment reproduces only about half this range—from about 100 to 7,000 cycles. Using special pickups and speakers, the finest hi-fi players reproduce it all.

Many phonographs have devices that change records automatically. In the type shown in the picture, two supports, called *selector arms,* hold a stack of records above the turntable. When the record on the turntable finishes playing, the selector arms open to drop the bottom record of the unplayed stack directly over the record on the turntable. The pickup arm automatically moves out of the way and then returns to begin playing the new record, readjusting itself to the height of the stack. These motions are *repeated until all the records have been played.* The electric motor that provides power for the turntable also runs the record changer mechanism. Coin-operated phonographs, popularly called "juke boxes," have selector arms that pick out of a stack any record the patron chooses.

Other Recording Devices

Sound can also be preserved by means of the wire recorder or tape recorder. The "record" is a steel wire or a paper or cellophane tape coated with metallic powder. The sound to be recorded is changed to its equivalent in electric current. This activates an electromagnet which magnetizes a moving wire or *tape in patterns that correspond to the sounds.*

The wire or tape can be played back at once through a special electrical amplifying system. The wire or tape can be demagnetized and used again and again. Tape is increasingly used for the initial recording of music intended for release on disk records. Unlike a master disk, tape can be edited with scissors and paste. The best parts of several performances can be spliced together to make a nearly perfect recording.

PHOSPHORESCENCE (*fŏs-for-ĕs'ĕns*) AND LUMINESCENCE. Is there any similarity between the flash of a firefly in the summer night and the glow of a luminous watch in the dark? Many minerals, especially the sulphides of calcium, strontium, and barium, shine in the dark, but they do so because they have been previously exposed to light. Living creatures also generate light, but in a way that is quite different. Phosphorescence, in its strict sense, applies only to the property possessed by some substances of continuing to shine in the dark, without giving off noticeable heat, after exposure to light or other forms of radiation.

The light of living organisms is more properly called luminescence or bioluminescence. It is not produced by phosphorus, which is a very poisonous element. In the lantern of the firefly there are two substances, *luciferin* and *luciferase.* These are manufactured by the cells of the animal. In the presence of air and water, luciferin unites with oxygen and produces light. Luciferase is a sort of enzyme or ferment which starts the process and keeps it going. Scientists believe that nearly all animal luminescence is produced in this way. In a few cases, as in some cuttlefishes, the light appears to be produced by bacteria localized in little tissue nests.

Many animals of the ocean are luminous, and the so-called phosphorescence of the sea is due to protozoa which happen to be present in enormous numbers. There are luminous fish, worms, centipedes, insects, and other forms of life. Luminous bacteria cause decaying flesh to emit light, and luminous fungi produce the "fox-fire" of rotting wood. Luminescence is often spoken of as "cold light."

PHOSPHORUS. The word "phosphorus" in Greek means "light bringing." Each time we light a match we can see why the chemical was given this name. Phosphorus burns readily, and rubbing it will produce heat enough to set it afire. In 1831 Charles Sauria discovered how to place phosphorus on match tips. It has been used on kitchen match tips or on safety match boxes ever since (*see* Matches).

The most important use for phosphorus, however, is in fertilizers. Calcium phosphate (a compound of phosphorus and calcium) is present in all fertile soil. Plants need it in order to live. The soil contains enough for wild plants; but when farmers take crops year after year from the soil, the supply of phosphorus must be renewed. Most commercial fertilizers contain phosphorus (*see* Fertilizers).

Animals as well as plants need phosphorus for health. They get their supply from the plants they eat. Good sources of phosphorus for human beings are milk, cottage cheese, fish, and egg yolks. Phosphorus is needed particularly in the formation of bones and teeth. Normal bones contain about 58 per cent of calcium phosphate.

Phosphorus is valuable for its effect on metals. For example, it strengthens steel. It is also used to make glass opalescent, in rat poisons, and in war for smoke screens and incendiary bombs.

Most of the phosphorus is obtained from phosphate rock, apatite, and bones. Phosphate rock, or phosphorite, occurs as a deposit in limestone and other rock and as pebbles in sands and clay. It is mined chiefly in North Africa, in Kazakhstan in central Soviet Asia, and in Florida, Tennessee, Montana, and Idaho. Apatite (calcium phosphate fluoride) is a rocklike mineral. It is mined in Canada, Norway, and Virginia. Phosphorus is derived from phosphate rock by heating it with carbon in an electric furnace. It is also obtained from bones by burning the bones and treating the ash with sulfuric acid.

Phosphorus is a chemical element. Hennig Brand, an alchemist of Hamburg, Germany, discovered it in 1669 while he was hunting for the "philosopher's stone." It does not occur alone in nature because it is intensely active. It is always found in combination with some other element. The most common combination is calcium phosphate. In this form it is abundant in certain rocks as well as in soil.

Phosphorus exists in different forms called allotropes. Yellow phosphorus is a waxy, glistening solid. In damp air it slowly oxidizes (rusts) and glows with a greenish-white light. It is extremely poisonous. Red phosphorus is nonpoisonous. It is made by heating yellow phosphorus in a closed container. (For chemical attributes of phosphorus, *see* Chemistry.)

How LIGHT *Makes* ELECTRICITY

PHOTOELECTRIC DEVICES. When doors open or drinking fountains bubble up seemingly by themselves as you approach, a photoelectric device is at work. These devices perform other amazing tasks. They are used to set off burglar alarms, detect fire and smoke, and act as safety guards on factory machines. They count objects, find impurities in drinking water, and can distinguish between more than 2 million shades of color. They reproduce sound from the sound track on motion-picture film, and they are important parts of television and telephotography mechanisms.

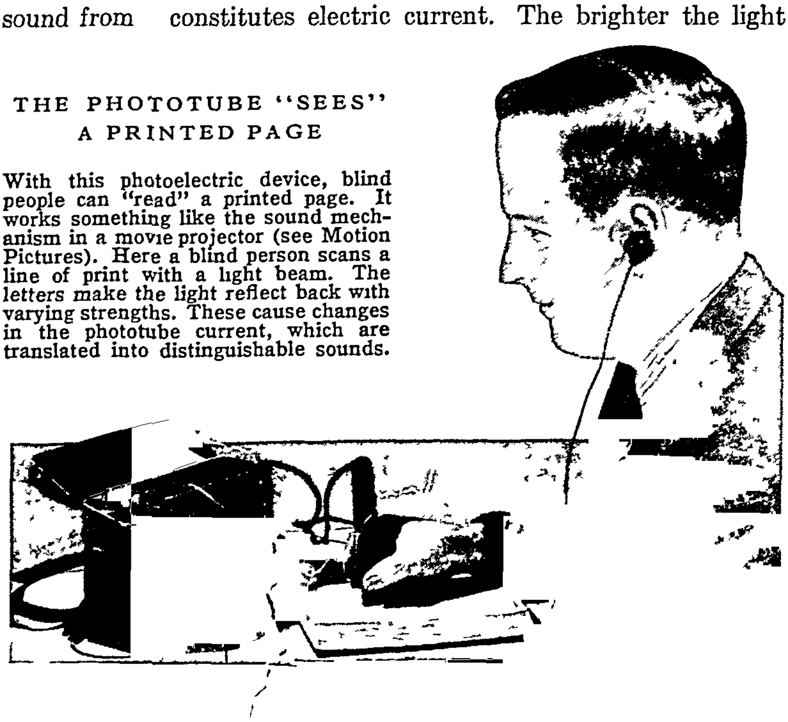
At the heart of all photoelectric devices is a small electronic tube called a *phototube*. The phototube is built to make use of an action called the *photoelectric effect*. This effect occurs when light strikes light-sensitive metal surfaces, causing them to give off electrons and to become positively charged.

How a Phototube Works

The phototube may be a vacuum tube, free of air and other gases, or it may be filled with an inert gas such as argon. It usually contains a curved piece of metal, called a *cathode*, and a slender rod, the *anode*. The cathode is coated with a metallic substance which is very sensitive to light. When a light beam strikes the cathode, electrons are instantly given off from the coating.

All light can be considered as being made up of separate packets of energy called *photons*. When photons strike the cathode, the electrons in the light-sensitive substance absorb their energy. The electrons thus acquire enough energy to escape from the surface of the metal. If the anode is positively charged the electrons are drawn to it.

This movement of electrons from cathode to anode constitutes electric current. The brighter the light



THE PHOTOTUBE "SEES" A PRINTED PAGE

With this photoelectric device, blind people can "read" a printed page. It works something like the sound mechanism in a movie projector (see Motion Pictures). Here a blind person scans a line of print with a light beam. The letters make the light reflect back with varying strengths. These cause changes in the phototube current, which are translated into distinguishable sounds.

that strikes the cathode, the greater the number of electrons that are released and the greater the current that flows through the tube. Thus any change in brightness, or intensity, of light falling on the tube instantly results in a change in the flow of electric current. Most photoelectric devices depend upon a changing light intensity to operate.

Light can tear electrons from all metals and from many other substances. The most *photosensitive* substances, that is, those which release the most electrons because of light, are the alkali metals (*see* Alkali Metals). Of this group, lithium, sodium, potassium, rubidium, and cesium are the most sensitive metals. These are used in coating phototube cathodes.

Phototube Amplifiers

The current through a phototube is too small to operate any device directly. It must first be amplified, or enlarged, by another tube, either vacuum or gas-filled. This *amplifier* tube is the same kind that is used in a radio receiver (*see* Radio). The amplifier is usually connected to a *magnetic relay*, which is a sensitive electric switch. This switch may turn on an alarm, start a motor, or run a counting device.

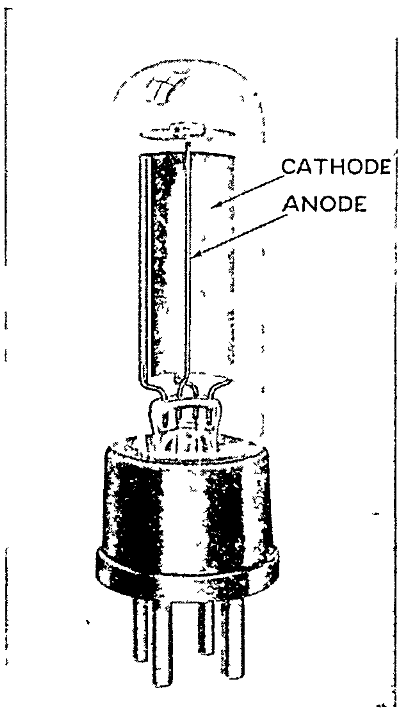
Some amplifiers work when the beam of light strikes the phototube cathode. Most of them work only when the beam is cut off. The bottom picture on this page shows how breaking a beam of infrared light rings a burglar alarm. As long as the light shines, the phototube current cuts off the amplifier current and the relay cannot operate. When the light is cut off, the phototube current stops, the amplifier current flows, and the relay closes the switch which rings the alarm.

The only tube that does not need an amplifier is the multiplier phototube. It has several anodes enclosed in one glass envelope. Electrons from the cathode strike the first anode with great velocity and knock out electrons from the anode. These released electrons (called *secondary emission* electrons) and the cathode electrons are now attracted to the second anode, which has a higher positive voltage. Each electron again releases more secondary electrons, and this continues, as they strike one anode after another. Current from the last anode is strong enough to operate certain devices.

Phototubes Respond to Colors

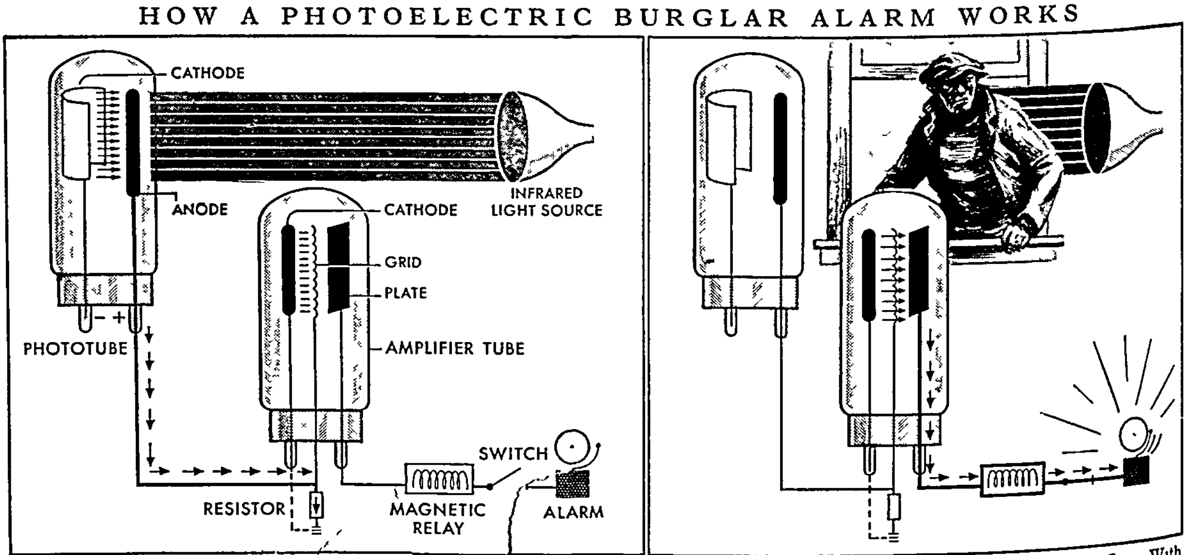
Phototubes are sensitive to selected colors, or wave lengths of light, depending on the kind of metal used on the cathode. Some metals give off most electrons when struck by visible light. Others respond more to infrared or selected frequencies of ultraviolet light. For each met-

THE VERSATILE PHOTOTUBE



Phototubes come in many sizes and with different arrangements of the elements. This one shows the important anode and cathode clearly. It is fitted to a standard four-prong tube base. Two of the prongs are idle, since terminals for only one current are needed to operate the tube.

HOW A PHOTOELECTRIC BURGLAR ALARM WORKS



Here we see how the phototube works as part of a burglar alarm. (The diagram is extremely simplified, and power sources are omitted.) At left, invisible infrared light shines on the phototube. Electrons flow from cathode to anode, and current from this anode flows through the resistor of the grid circuit of the amplifier tube. This gives the grid a high negative charge. When the grid is negative, electrons from the amplifier cathode are repelled by this negative charge and current will not flow. With no amplifier current, the alarm cannot ring. At right, an intruder breaks the infrared light beam. With no light, current will not flow through the phototube. The amplifier grid is now less negative than when the light was unbroken. Now current flows from the amplifier cathode to the plate. This energizes the magnetic relay which closes the circuit and sounds the alarm.

al there is a certain frequency above or below which no photoelectric effect takes place. If red or infrared light is to be detected, the cathode is usually coated with cesium or cesium oxide on a silver base. A potassium surface is most sensitive to a deep purple light. For ultraviolet light, a sodium coating is used.

A change in the color of light changes the phototube current. This effect is used to safeguard the purity of drinking water. A light shining on the water in the mains is reflected to a phototube. Even a slight discoloration in the water changes the phototube current. This change starts a device which reroutes water from the mains. When discoloration disappears the device lets water flow again.

How Photographic Light Meters Work

Light not only releases electrons from photosensitive substances; it can also generate an electric current. The voltage of this current increases with the amount of light striking the photosensitive substance. This photoelectric action is called the *photovoltaic* effect, and a device which uses this principle is a *photovoltaic cell.* The cell usually consists of a light-sensitive substance that is laid on a semiconductor, such as selenium, to form a kind of "sandwich." The two are supported on an iron base.

When it is exposed to light this cell acts like a battery. When a light beam strikes the surface of the substance, a measurable electric current flows through the "sandwich." The light meter used by photographers is an application of the photovoltaic effect. It measures the amount of light falling on a subject to be photographed By conversion tables (usually built into the meter) the settings for lens aperture and shutter speed of the camera can be determined.

How PICTURES *Are Made into* PRINTING PLATES

PHOTOENGRAVING AND PHOTOLITHOGRAPHY. Today newspapers, magazines, and books are filled with all sorts of pictures, from comic strips to reproductions of famous paintings. They include photographs, maps, graphs, diagrams, and a great variety of drawings and paintings. Colors may range from black and white to all the hues found in nature.

To turn these pictures into print, one of three processes may be used: *photoengraving*, *photogravure*, or *photolithography*. As the prefix "photo" indicates, all three are based on photographic methods. The pictures are copied by a camera and then transferred to the metal that serves as a printing surface. Other than these general similarities, the processes differ sharply. To the trained eye each produces a printed picture that differs in quality and effect.

Photoengraving

PICK UP a rubber stamp and notice the lettering or design that leaves its inked mark, or impression, on paper. This is raised from the surface; that is, it stands in *relief*. The letter on a piece of printing type also stands in relief, and in printing the letters, after being inked, are pressed against the paper. Thus printing from type (or from a plate made from type) is called *letterpress* printing (*see* Printing).

Making Line Engravings

A picture that accompanies words in letterpress printing must also present a relief surface to receive ink. The simplest type of a letterpress plate is a *line engraving*. It is usually made from a drawing composed of lines and areas with no gradations of shade or tone—a graph, for example.

The first step is to make a photographic *negative* of the drawing, or *copy,* reduced or enlarged to the size wanted for the final reproduction. On the negative film or plate, the lines and solids of the copy will be completely transparent and the white spaces will show as solid black.

The negative not only reverses the blacks and whites; it also reverses the picture, as in a mirror. The printing plate made from this negative must also be a mirror image in order to print correctly on paper. To do this, the negative must be turned over. This turning may be done by photographing the copy through a prism or by stripping the negative from its original support. A stripped negative may be combined with others to make a composite plate.

After turning, the negative is ready to print on a light-sensitive surface backed by a sheet of zinc, one sixteenth of an inch thick (called "16 gauge"). The surface is made photosensitive by application of a solution of egg albumen and ammonium bichromate in water. In a printing frame the sensitized zinc is exposed to light from a powerful arc lamp through the negative. Black areas on the negative (which were white on the copy) stop the light. Transparent areas allow light to pass through and harden the exposed portions of the sensitized surface.

After exposure, the surface is covered with a thin black etching ink and then washed with water. The soft, unexposed portions, including their ink coverings, wash away. The hardened portions, with their ink, remain. This stage of the process is called an *ink print.* The ink print resembles the original copy except that it is a mirror image.

Next the surface is dusted with a resin topping powder, which sticks to the inked image only. The plate is dipped in an acid bath several times. The ink and topping powder protect the image; the rest of the surface is gradually etched, or eaten, away. Between dips, or "bites," in the acid another resinous powder, called *dragon's blood,* is brushed against the lateral walls of the image area. This protects the image against being eaten away from underneath by the acid.

After etching, the plate is cleaned and *routed.* The router is a high-speed mechanical cutter that deepens the larger etched areas of the plate and removes unwanted "dead metal" along the edges.

The *Ben Day* process is used to add a tint or a uniform pattern to a line engraving. The engraver works

PHOTOGRAPHING THE ORIGINAL COPY

As the first step in making a halftone, the original picture is photographed. The powerful arc lamp throws light on the copy, which is reflected into the camera. The light passes through a halftone screen and carries both the image and the halftone pattern to the film.

with a shading machine that has a film of semitransparent gelatin holding the Ben Day pattern on its underside. He inks the pattern side and transfers it either to the negative or to the zinc plate before etching. He can choose from more than 100 patterns—stipple, grain, stripes, tints, lines, and texture effects. The artist can achieve the same effects on the original by laying on it a transparent adhesive sheet of the pattern.

Making Halftone Engravings

The line engraving is suitable for printing pictorial matter that needs no gradation of shades or tones. To print a picture with tonal gradations in the letterpress process, a *halftone* engraving is used.

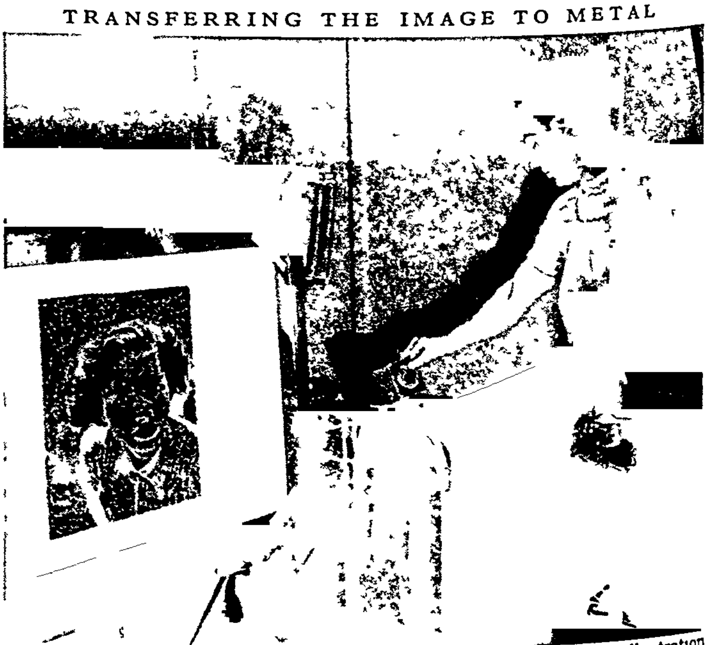
Making a halftone engraving begins with making a photographic negative of the copy. This negative is made in a special way. Inside the camera, between the film and the lens, is a halftone screen. The screen is made of two glass plates which are cemented together. One is ruled with fine horizontal lines, the other with vertical lines. Together they form a mesh of tiny squares. An arc lamp floods the copy with light. Dark areas on the copy absorb most of the light and reflect only a small amount. Bright areas absorb little light, reflecting the rest. The reflected light passes into the camera. As it goes through the screen the light is broken by the tiny lines of the screen into thousands of separate beams.

These beams "burn" tiny dots into the emulsion of the film. The smallest dot can be seen only with a magnifying glass; the largest is about the size of a pinhead. The diameter of each dot depends on the strength of the reflected light which gets its strength from the brightness of the copy area from which it is reflected. Thus the negative is covered with a pattern of dots. The dots are equally spaced from their centers and they vary in diameter according to the brightness of the corresponding areas of the copy.

The negative is printed on a sensitized plate, usually made of copper. Then this plate is etched in much the same way as a line engraving. The etching acid eats the dot pattern into the plate, making it look like this in cross section:

These dots transfer ink to the paper. They blend in the viewer's eye to re-form the tones of the original

TRANSFERRING THE IMAGE TO METAL



Here the photographic negative of the picture shown in the first illustration is being imprinted on the sensitized surface of a sheet of copper. Both the negative and the metal are of the size wanted for final reproduction.

picture. Halftone screens are classed by the number of lines to the linear (not square) inch. They range from 50 to 150 lines per inch. The choice of screen depends on the kind of paper to be used. The halftone engravings used in Compton's Pictured Encyclopedia are made with 120-line screens. This screen has 120 ×120, or 14,400, tiny squares to each square inch of screen surface.

Photogravure GRAVURE printing is sometimes called *intaglio* printing because the areas that receive ink are below the surface of the plate. In several ways, gravure printing is the reverse of letterpress.

In letterpress the raised surfaces are inked; in gravure, the depressed surfaces are inked. (Actually the whole plate is inked; then a "doctor blade" wipes the surface portion clean.) Both types of engravings are made with screens. In letterpress the dots vary in diameter; in gravure the dots are of equal diameter but vary in depth. A negative transparent film is used in letterpress; in gravure, a positive transparency transfers the image to metal.

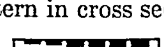
Making a Photogravure Plate

The gravure screen is black glass, crisscrossed with transparent lines. Platemaking begins when this screen pattern is printed on a special paper called *carbon tissue.* The paper is first prepared by coating it with gelatin, then dipping it in a bichromate solution to make it photosensitive. By passing a strong light through the screen its squares are imprinted into the gelatin. The lines in the gelatin harden, making them insoluble in water.

The positive transparency is then laid over the lined gelatin and a strong light turned on it. Clear areas on the transparency allow much light to pass through; dense areas allow only a little. The gelatin under the clear areas hardens nearly all the way through; under the dense areas the gelatin hardens only on its surface. Thus the depth of hardness in the gelatin squares depends upon the amount of light they receive. In turn this light varies according to the clear and dense areas on the film.

Now the carbon tissue is wetted and laid exposed side down on a copper plate (usually curved). The paper is peeled away, leaving the gelatin squares sticking to the plate. The plate is then carefully washed to remove the unhardened, soluble gelatin. This leaves the plate covered with gelatin squares, which stand at various heights.

In the etching bath the acid eats through the gelatin to make tiny cups in the metal. The speed of the acid's action depends upon the height of the squares. Low squares allow deep cups; high squares shallow ones. The dot pattern in cross section looks like this:



In printing, a fluid ink is used. Each cup fills up with ink, but the shallow ones can hold only a small amount. They leave smaller dots on paper; the deep cups print larger dots to recreate the darker areas

IN A HALFTONE EACH DOT IS IMPORTANT

After a halftone is produced by photomechanical methods, handwork is often needed to improve it. Here a skilled engraver tools out dots in areas that are to be completely white.

At the left is an enlargement of the girl's eye from the plate above. At the right a small portion of it is "blown up." Comparing the two shows how separate dots blend to form tones.

of the original copy. The gravure process uses fine screens, from 150 to 200 lines. To print words (text) by the gravure process, the copy is set in type and a proof taken. The proof sheet is photographed and is thereafter treated as a picture.

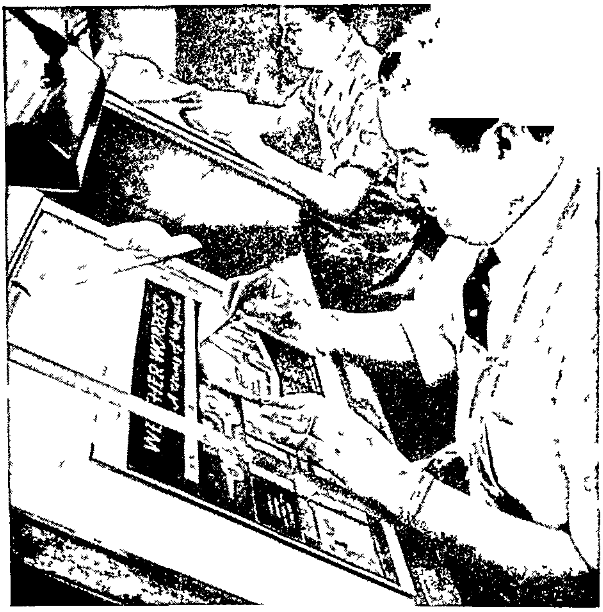
Photolithography LITHOGRAPHY is printing from a plane surface and so it is sometimes called *planographic* printing. Printing can take place from such a surface because the image areas are treated with grease and the nonprinting areas are covered with a film of water. Ink sticks to the grease but is repelled by the water.

Making a Photolithographic Plate

The surface of the metal to be used, usually zinc or aluminum, is first treated to give it a kind of texture, or *grain.* This is done by applying a film of sand and abrasive to the surface, then rolling steel "marbles" over it. After washing, the surface is coated with a photosensitive substance, similar to the one used in making zinc line engravings.

A photographic negative, prepared either as a line or screened halftone (as in letterpress), is used to transfer the image to metal. The print on the metal is coated with a greasy litho ink and developed under water. The ink is washed off the portions of the plate not affected by light and remains fixed on the exposed

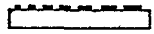
HOW PICTURES ARE GROUPED INTO COMPOSITES



Skilled workers are stripping negatives from their original supports and bringing them together to make composites. This process is used in both photoengraving and photolithography.

areas. Now the plate is delicately etched in weak acid. The acid bites only deep enough to help the non-printing areas hold water. These areas are treated with gum arabic that retains moisture. On the press a water roller passes over the whole plate. The non-printing areas absorb the water; the greasy printing areas repel it. When the ink roller passes over the plate the process is reversed.

Deep-etch lithographic platemaking is a complex process. The result is a nearly plane plate etched to a depth of about 1/2000 of an inch, considerably less than the etched depth of a letterpress plate Deep-etch plates last a long time on the press and they produce a fine printed picture. In cross section all lithographic plates look like this:

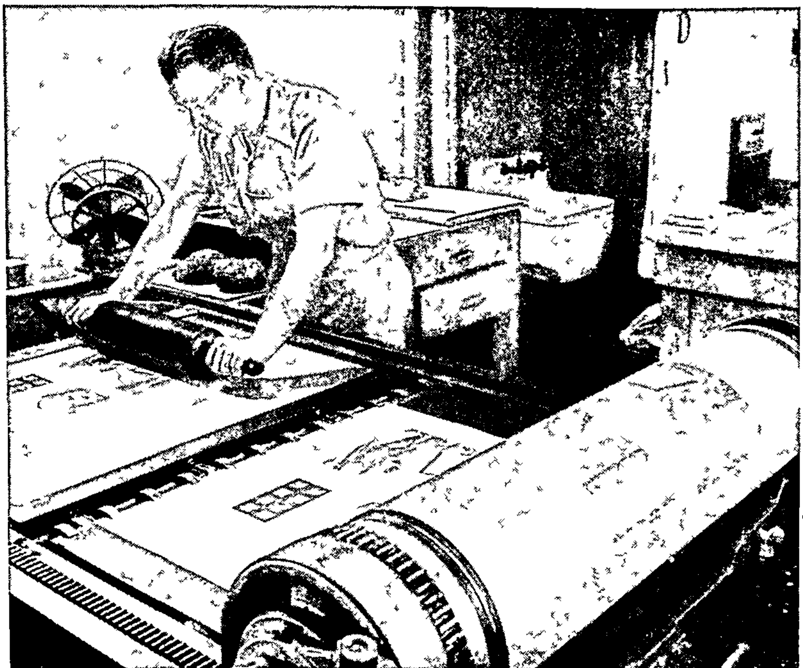


Much lithographic printing is done by the *offset* method although *direct* lithography is still widely used In offset, instead of the inked plate meeting the paper directly, the image is first "offset" to a rubber "blanket" and from there transferred to the paper This added step means that the negative used in making the plate need not be turned over. The plate is the same as the copy; the impression on the blanket is a mirror image of the copy; and the final impression on paper is again like the copy.

Making Color Engravings

PICTURES with several colors can be reproduced by any of the three processes. *Color separation* is the first step. The original colored copy is photographed through a filter that allows only one color to pass through. A different filter must be used and a separate photograph made for each color plate. These color plates are usually black and the three primary colors: red, blue, and yellow. These four colors, blended by the dot pattern, are used to reproduce all the colors of the spectrum (*see* Color). The black provides the gray tones. These gray tones tint and emphasize the other colors.

AN OFFSET LITHOGRAPHY PROOF PRESS



Here a printer is preparing to "pull" a proof from an offset lithographic plate. He is inking the plate itself. The curved rubber blanket at the right will roll over the plate, pick up an impression, and transfer it to paper.

The color-separated negatives can be used to prepare plates for any of the printing processes Each of the four one-color negatives is made into a separate plate. The same techniques are used in making plates for each color. On the press each plate is inked in its own color. The paper passes successively under each color plate and the printed reproduction shows the full colors of the original.

In letterpress and lithography this re-creation of full colors is achieved by the blending of the primary dot colors in the viewer's eyes. In fine gravure printing, the colors actually print one on top of the other, and a true blending takes place.

History of Platemaking

WOODCUTS had been in use for some centuries before movable type was invented (*see* Engraving; Printing). Woodcut artists could get tonal effects by using gravure techniques, but such

woodcuts could not be used with type. Relief woodcuts were like line engravings, without tonal gradation, and could be used with type. In 1784 the English woodcut artist Thomas Bewick published his illustrated 'Select Fables'. By using the end grain of hard, dense wood he made tonal relief reproductions that could be printed with type.

The lithography principle was discovered by Alois Senefelder in the 1790's (*see* Lithography). Until photolithography came into use, many lithographic artists drew directly on the stone "plates" with wax crayons. They made separate plates for multicolor printing. (*See also* Currier and Ives.)

The discovery of photography was the start of modern methods of picture reproduction (*see* Photography). A pioneer photographer, Henry Fox Talbot, made two important contributions. He discovered how to make photographic negatives, and he worked out a photogravure process that foreshadowed the modern method. Paul Pretsch, of Vienna, made molds from light-hardened gelatin that could be used as relief or intaglio plates.

The first workable halftone screen was patented by Frederick von Egloffstein, an American, in 1865. The same year William A. Leggo, of Canada, patented his own halftone method, which he called *Leggotype*. In 1869 the *Canadian Illustrated News* published the first halftone pictures ever to appear in a periodical, using Leggotype halftones.

Modern halftone screens were developed by Frederick E. Ives of the United States in 1885-86. The Levy brothers of Philadelphia refined the manufacture of Ives's screen and established modern industrial production methods for it.

How PHOTOGRAPHY *Has* ENRICHED *Our* LIVES

A Simple Camera Can Record Vacation Scenes and Events for Renewed Enjoyment in Later Years

PHOTOGRAPHY. A little more than a hundred years ago, pictures were rare. Only the most expensive books had good illustrations; only the wealthy could have fine pictures in their homes. People had few pictures, because about the only way to get one was to have an artist paint or draw it.

Today we see pictures everywhere. They meet our eyes in newspapers, books, and magazines, on billboards and in stores. We can see motion pictures in a theater or at home. Almost everyone has a collection of studio photographs or snapshots of relatives and friends, home scenes, vacation trips, and other interesting subjects.

All this has been brought about by the invention of photography. The word itself tells what photography does. It comes from Greek terms meaning "light" and "writing"; and photography does "write with light." When a film is exposed in a camera, light impresses every detail of the scene before the camera on the film almost instantly. Then a few simple operations give a finished picture. Photography also makes possible fast, inexpensive methods of printing pictures in books, magazines, or newspapers, and for sending them by wire or radio.

A Splendid Hobby

As a hobby, nothing can be more interesting than taking pictures. It is easy to operate a camera, and expenses can be kept low. Pictures may be taken indoors or outside, as desired. Many people like to hunt with a camera instead of a gun, or to take and

keep pictures of wild flowers, instead of picking them. Best of all, the hobby is easy to learn. An amateur can start once he can do three things correctly. He must know how to load his camera with film. He must know how to hold it and snap the trigger release to take a picture. Finally, he must know how to judge light conditions and allow for them.

The operations of loading and snapping vary with the type of camera. Anyone who knows the particular camera a beginner has can explain everything in a few minutes. Full instructions can be obtained if desired in any photographic supply store. Then a little time and practise will be needed for learning how to judge light and expose correctly.

Hints for Taking Good Pictures

The box camera is the simplest of all to use. This type has no focusing arrangement, and so the user need only point the camera correctly and choose the right exposure.

Pointing must be watched, because failure to do so correctly is a common cause of poor pictures. We often see pictures of persons or groups which do not include all of a face or head. Interesting parts of buildings or scenes may be omitted, or the picture may be badly tilted. All these faults can be avoided by correct use of the view finder on the camera.

View finders vary with the type of camera, but one point to remember is the same for all. Many beginners get poor pictures because they use the view finder to point the camera, and then look up when they take the picture. Meanwhile they have moved the camera. The correct way is to look in the view finder *while snapping the picture.*

Another common mistake of beginners is double exposure—that is, taking two pictures on the same piece of film. This can be avoided by adopting a simple rule: *always* turn to the next frame *immediately* after taking the picture. Then the camera will be ready and there will be no double exposures.

Judging Light and Exposure Time

The final task in simple picture taking is judging exposure time to suit the intensity of light. All but the cheapest cameras offer several choices. The frame around the lens has a pointer which can be moved to positions marked B, T, 1, 1/10, 1/25, and perhaps several other fractions. By moving the pointer, any one of these exposure times can be used.

WHAT POOR FOCUSING CAN DO

Above, a good picture was spoiled because the photographer did not set his camera correctly for distance. Below is the same subject taken with correct focus. The clouds are out of focus, but this is not objectionable.

The marks B and T provide for "bulb" and "time" exposures. They are used for exposures of from more than a second to several minutes. They are needed only for indoor shots, night scenes, and subjects in dense shadow out of doors. They are explained more fully later in the article.

The other settings give *instantaneous* exposures. This means that the shutter *opens and closes* at one touch on the release in the time interval marked. The figure 1 is for one second, 1/25 for 1/25 of a second, and so on. These are the exposures most useful to amateurs. Some principles governing their choice are explained later in the article, but the beginner will do best by following the instructions given with every roll of film. Then he should keep a record of his exposures and study his results for underexposure and overexposure.

Underexposure occurs if the film does not get light enough to make a good picture. It occurs when too short an exposure is given on cloudy days or when the subject was in shadow. The picture looks thin and washed out. Overexposure results from admitting too much light. It produces a dark-looking, muddy picture. If a beginner keeps a record of light conditions and the exposures used for all his pictures, he will soon learn what exposures to use.

The Need for Focusing

All the better cameras have some arrangement for moving the lens to focus the camera and get faithful reproduction of fine detail. A box camera which does not have this arrangement has *universal* focus. It will record detail beyond a certain minimum distance. The minimum is often marked on the camera; it is usually about eight or ten feet.

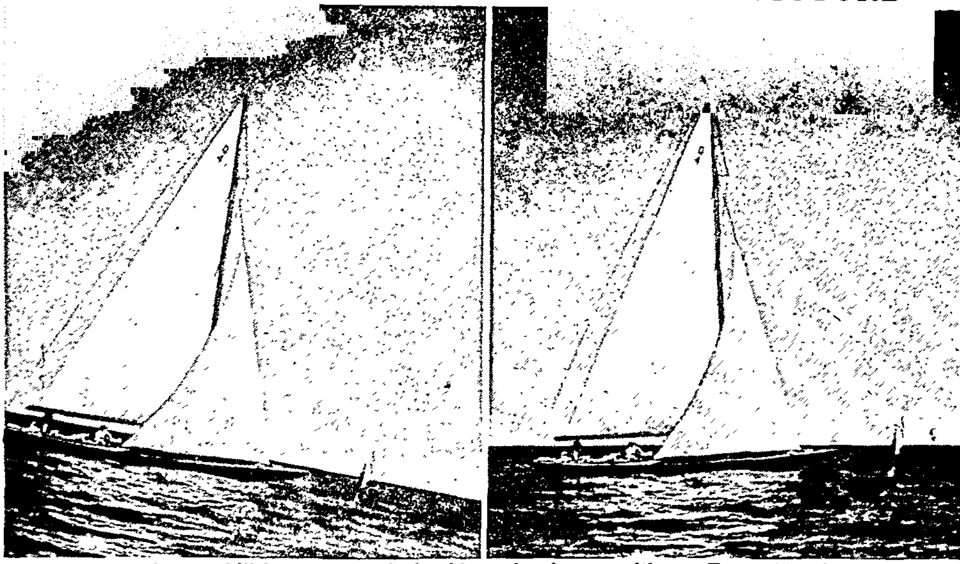
Focusing cameras have a scale of distances marked on the front and must be set correctly for each picture. The closer the subject, the more accurately the distance must be known. Anyone who cannot estimate

distances correctly should use a tape measure, just as Hollywood cameramen do.

Another cause of blurring is movement of subject or camera during exposure. Even 1/25 of a second is not short enough to "stop" all ordinary movement, and a steady hand is needed to hold the camera for this exposure. A better plan is to rest the camera on something for this and longer exposures.

A good photographer always watches backgrounds. If his subject is a person or object near the camera, the background should be simple and uncluttered. A fence or the side of a clapboard house, for example, is likely to prove bad. Solid shrubbery is better. Whatever the background, the photographer should always watch the background around a subject's head for possible unfortunate effects. Carelessness may produce a print with trees looking as though they grew from a subject's head, or a stray shadow may look like a beard.

A TILTED CAMERA MAKES A FOOLISH PICTURE



Boats do not sail downhill in nature and should not in pictures either. To avoid a bad result like that at the left, hold the camera level. Tilted pictures can sometimes be corrected by cropping.

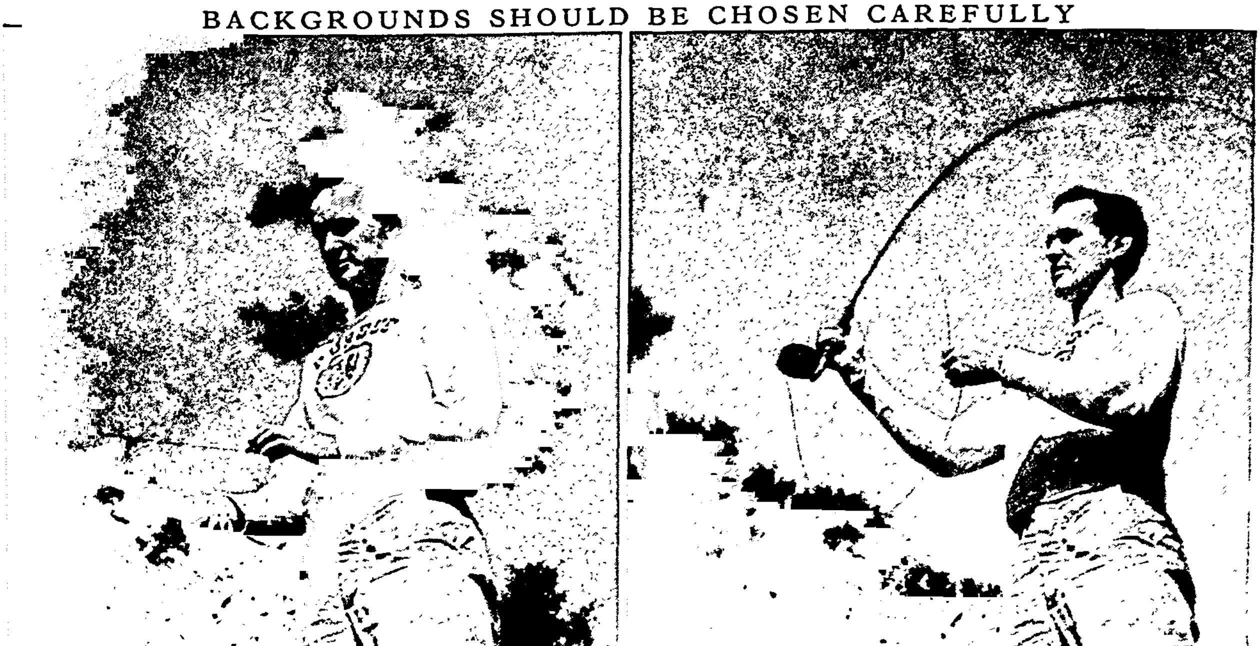
What Developing Accomplishes

Exposed film can be sent to a drugstore or photographic dealer to be processed. But many amateurs prefer to do their own work. Photofinishing is simple and interesting, and it is less expensive to do this work at home than to have it done professionally.

Since exposed film remains sensitive to light until it has been developed and fixed with chemicals, developing must be done in a *darkroom.* This may be a small room which can be completely darkened or it may be just a curtained corner in a basement.

Certain colors of light will not affect film (except the panchromatic types). The darkroom may have a special bulb or lamp to give illumination enough to let the photographer see what he is doing. Such a light is called a *safelight.* Safelights are made and colored correctly to suit different kinds of films. Access to sink and faucet for running water is desirable but not indispensable. All prolonged washing that will be needed can be done outside

BACKGROUNDS SHOULD BE CHOSEN CAREFULLY



At the left, a distracting background mars the interest of the picture. But by changing his position a few feet, the photographer got the pleasant results shown at the right. Here the harmonious lines of the trees add to the picture's interest.

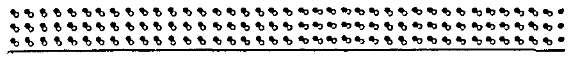
the darkroom. The following equipment is essential for developing films and printing pictures:

Safelight
Three photographic trays, each 5x7 inches
Measuring cup or glass
Thermometer
Printing frame
Printing paper
Chemicals for developing
Chemicals for fixing
A watch or clock

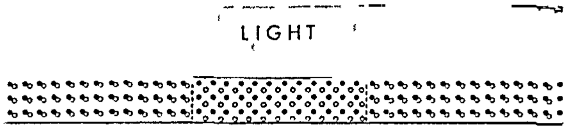
Other desirable items are a cord and clips for hanging films up to dry.

Development brings out the image which was impressed on the film by light. The chemical processes involved are indicated by diagrams on this page and explained more fully later in the article. The process changes the exposed film into a *negative*. All light areas in the original subject or scene look dark, and all dark areas look light. When a print is made from the negative on printing paper, the tone values are reversed again and appear correctly. For this reason the print is called a *positive*.

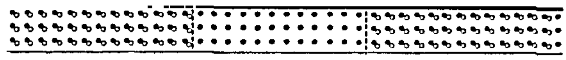
HOW LIGHT MAKES PICTURES ON FILM



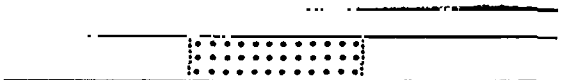
Photographic film has two layers—a transparent base and an emulsion of gelatin and a light-sensitive salt such as silver bromide.



Wherever light strikes the film, the salt breaks down into free silver grains (black dots) and bromine atoms (white dots).



Developing washes away the free bromine, leaving free silver in the exposed parts. Silver bromide is left in unexposed parts.



Fixing takes away the silver bromide. Now only silver particles remain in the exposed parts. These particles intercept light and give a dark appearance when light is passed through the film.

Film can be developed either with trays or in a tank. For tray development, one tray is filled with developing solution, another with water or very dilute acetic acid, and a third with hypo solution. The photographer removes the film from the camera, and moves it back and forth through the developer, as shown in the picture on the next page, until the images are fully developed. The time allowed and the solution used should follow the directions which come with the chemicals.

Next, the photographer washes the film in the water (or dilute acid). At this stage the film looks milky, even though the images show clearly. The milkiness is caused by light-sensitive chemicals which were not changed by the exposure. They could still change and ruin the film. But washing through the hypo removes them and *fixes* the film. It can be exposed to light without risk of change.

Next the film is washed in running water for 20 minutes or half an hour to remove all traces of hypo. Then it must be hung up for several hours to dry. When dry, it can be cut into individual negatives before prints are made.

In tank development a light-tight tank is used to hold the film and the various solutions in turn. The film is wound on a reel which drops into the tank. After the tank has been loaded with film in the dark, the photographer can work in ordinary light. First he

A NEGATIVE AND A POSITIVE IMAGE OF THE SAME SCENE

Developed and fixed film has a negative image, as shown at the left. Dark and light tones are reversed. When a positive print is made from such a negative, the tones are again reversed. Then they correspond to those of the original subject (right).

PHOTOFINISHING AT HOME

pours developer through a hole in the top of the tank. Then he changes the solutions at prescribed times, since he cannot watch the development as it proceeds.

Printing and Enlarging

The final step, after the negatives are ready, is making positive prints. The easiest way is by the contact method, using a printing frame. This is somewhat like a picture frame, with a piece of glass in front and a removable back. To make a print, the photographer places the negative against the glass and a piece of printing paper next to it, with the coated side next to the negative. Then he locks them back in place.

This much should be done under a safelight. When the frame is locked, the negative and paper are exposed to a bright light for a few seconds, the time depending on the density of the negative. Then the print is developed and fixed in trays under a safelight.

Such contact prints are always the same size as the negative. Frequently a photographer will want an enlargement of good pictures. Such printing can be done with an enlarging machine. The projector is adjusted until it throws the size of picture desired on the easel. Then a piece of enlarging paper is exposed, and the print is finished like a contact print.

Enlargers are somewhat expensive, but anyone who is handy with tools can make one if he desires. Full directions can be found in books that are available in almost any library.

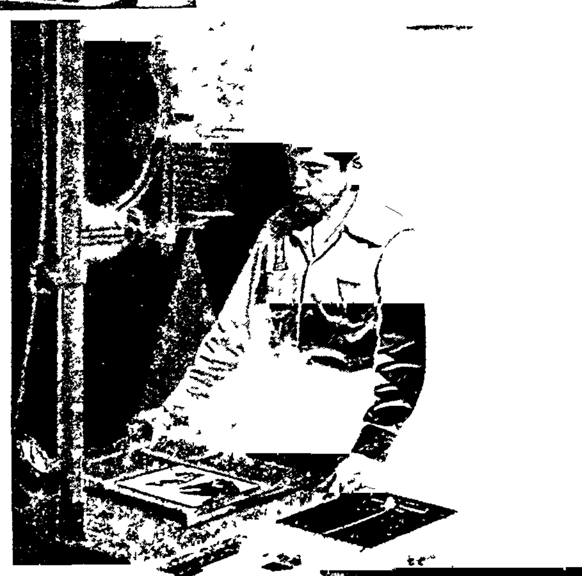
Taking Pictures Indoors

Many amateurs become interested in taking portraits and other pictures indoors. The most important problem is lighting. Light from a single window or one electric light bulb is harsh, giving deep shadows and highlights that are too strong. Good lighting can be obtained by using more than one light source and reflectors. A reflector is a board two or three feet square covered with some shiny material such as tinfoil.

For portraits by natural light the photographer should place his subject close to an unobstructed window, with a reflector placed to soften the shadow. The camera is best placed close to the wall on one side of the window If it is pointed directly at the window, the picture will be spoiled by *halation* (fogging along the edge of the bright area).

At night, crosslighting can be obtained with ordinary light bulbs, photoflash bulbs, or photofloods. A *photoflash* is a bulb filled with aluminum foil and ignited electrically. It gives off a flash of brilliant light. *Photofloods* are tungsten-filament bulbs which produce a continuous white light. Lighting setups should be made with household light bulbs first. Then photofloods can be screwed into the same sockets. It is easiest to take photoflash pictures using a device which synchronizes flash and shutter. But without it, the shutter can be opened, the flash set off, and the shutter closed.

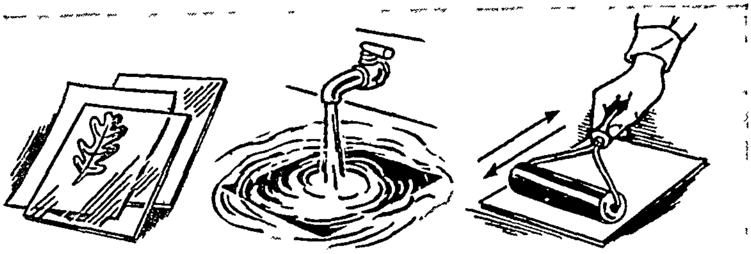
Any amateur who wants to develop skill beyond the beginner's level should understand the basic principles of photography. Experiments pictured on the next three pages employ and illustrate some of these principles. These are followed by an explanation of the chemical processes and of the operating techniques of photography.



These three pictures illustrate some of the processes of photofinishing. At the top, a young amateur is developing a roll of film by the tray method. Next, he is making a contact print with a printing frame. In the bottom picture he is shown making an enlarged print.

Making Blueprints

Blueprint paper is sensitive to light and can be used like photographic print paper. It may be bought at large stationery stores or science supply houses Silhouettes of leaves, paper cutouts, or even prints from photographic negatives can be made with it. Follow the instructions supplied with the paper for details of procedure.



1. Lay a leaf and blue print paper between two pieces of glass. Expose to sunlight for 30 seconds.

2. Wash the print in cold running water for a few minutes, until the image is sharp and clear.

3. To dry the print, lay it inside pieces of blotting paper and press it dry on each side with a roller.

Silhouettes on Printing Paper

Leaves, paper cutouts, or other opaque objects can be used to form interesting designs on regular contact printing paper. They must be arranged on the paper and placed in a printing frame under a safelight. Once the arrangement is complete, print just as though the design were a photographic negative and develop in the usual way.

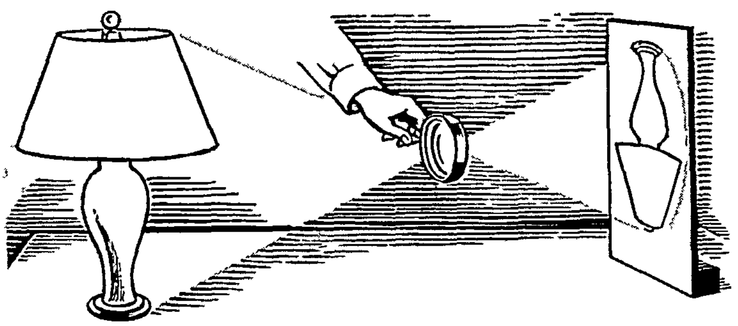
1. Under safe light, lay object on paper in a printing frame.

2. Expose the object to bright light for about five seconds.

3. Develop the print in the usual way.

Forming an Image with a Lens

This experiment will show how a camera lens forms an image on the film. Use a regular magnifying glass to form an image on a piece of stiff paper. The distance from the lens to the paper varies with different lenses but can easily be found by trial. Notice that the image is upside down. This is the way the image is formed in a camera.

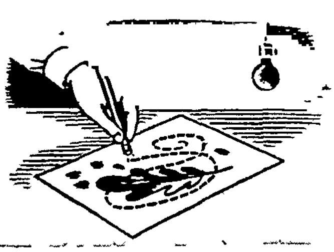


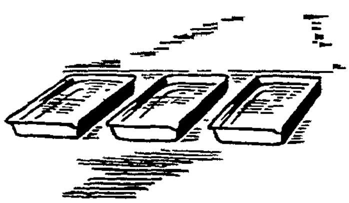
This experiment shows how a lens forms an image.

Making Photograms with a Flashlight

Photograms can be written or drawn on enlarging paper with a pencil flashlight. Lay the paper under a safelight and write or draw as desired, holding the flashlight close to get a narrow beam. Objects can be laid on the paper to give shadow designs if desired. After tracing the design, develop the paper in the usual way.

Below, an experimenter is making a photogram with a pencil flashlight.





After the photogram has been made, develop in the usual way.

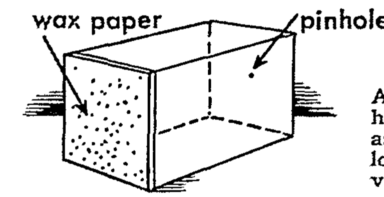
Making Photo Stencils for Greeting Cards

Write or draw a design with India ink on a piece of clear celluloid or glass which is free from all trace of oil or scum. Use the result as a negative to make regular prints on printing paper. The print will have white lines where you used black ink, and a black background. Such a design can be printed together with a regular negative to make greeting cards, title designs, or novelty pictures of various kinds.

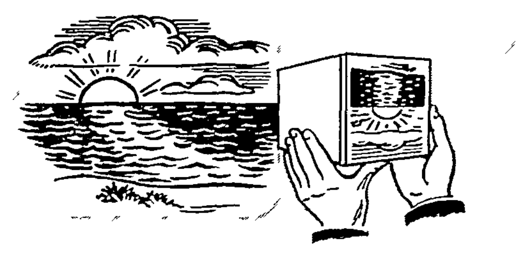
At the left an experimenter is making a design for a photo stencil. At the right is a specimen print.

A Viewing Pinhole Camera

A kit with everything needed to make a pinhole camera good enough to take pictures can be bought from photographic supply houses. But one can be made well enough from any small, light-tight box to show how such a device works. Cut a section out of one end, and paste some waxed paper over the space to serve as a viewing screen. In the other end make a fine hole with a needle. Point the hole at a bright scene. If the pinhole was neatly and carefully made, an image of the scene will appear on the waxed paper screen.



At the left is a pinhole camera, made as described. Below, it is used to view a scene.



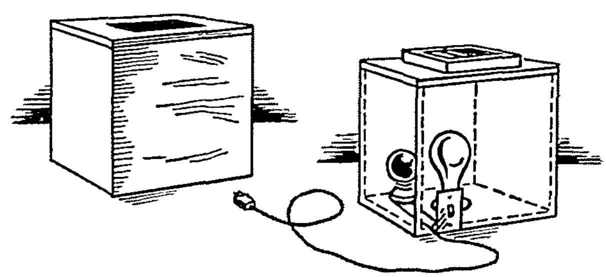
A Box for Making Prints

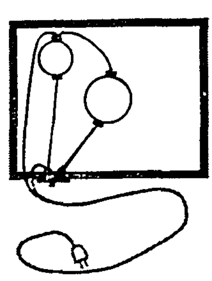
Holding a printing frame up to a bright light each time you make a print becomes a nuisance, if you make very many. Printing can be done much faster and more easily by making a print box with a white light and a safelight inside. A good one can be made without much trouble.

First make a plain box without a top from any suitable lumber. It should be about eight inches wide, ten inches long, and ten inches high. It must be made light-tight or taped to prevent leakage of light.

Make the top of the box separately to the right size. In it cut an opening slightly smaller than the print frame. Screw the frame over this opening so it becomes part of the top.

Equip the bottom of the box inside with two light sockets. One for bright light should be centered directly under the print frame. Install another socket for a safelight off to one side. When the two are wired as shown in the wiring diagram, the safelight will be on as long as the box is plugged in on an outlet. An ordinary wall switch installed on the side of the box as shown will turn the bright light on and off as needed to expose prints. Younger builders should have an adult help with the wiring to insure a safe result. And no work should ever be done on the box while the cord is plugged into an outlet.





At the upper left is a print box. At the upper right is a view of the safe and bright lights inside. At the left is a wiring diagram for the lights. Below, the box is in use, making a print.

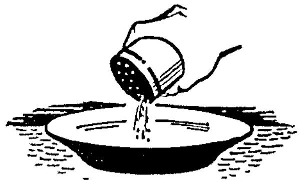
CHEMICAL EXPERIMENTS IN PHOTOGRAPHY

The experiments shown here illustrate the chemical basis of photography. The necessary chemicals may be obtained from any chemical supply house. The experimenter should be cautious in handling them since some of them are poisonous. It is well to have adult supervision at home or to perform the experiments in school with help from the science teacher.

Showing How Light Affects Silver Nitrate

1. Dissolve a few crystals of silver nitrate in a saucer of water.

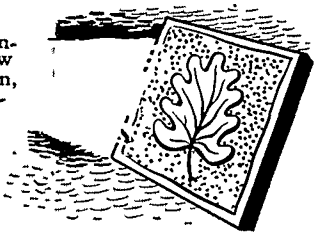
2. In another saucer dissolve some salt.



3. Soak a piece of white paper in the salt solution and drain. Dip it in the silver nitrate solution.

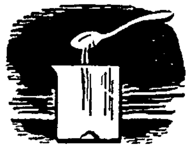
4. Place the paper on a flat surface and put a leaf or other opaque object on it.

5. Expose to direct sunlight and observe how the paper will darken, leaving a white silhouette

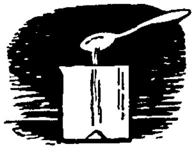


Showing How Light Affects Silver Bromide

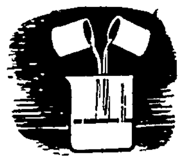
1. Dissolve a few crystals of silver nitrate in a tablespoon of water.

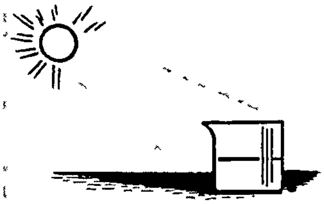


2. Dissolve a bit of potassium bromide in another tablespoon of water.

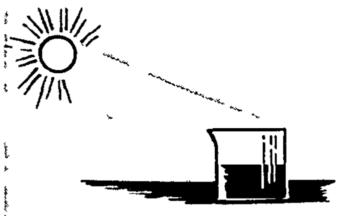


3. Mix the two solutions together in a small glass. This makes silver bromide.





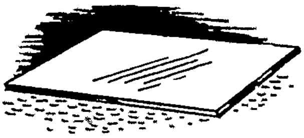
4. Expose the mixed solutions to sunlight.



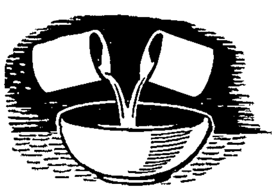
5. The mixture will turn purple. The silver bromide in it has been turned to particles of silver and bromine gas by the action of light.

Making a Piece of Experimental Film

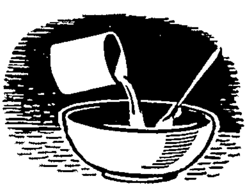
1. Get a piece of clean glass or clear celluloid.



2. Dissolve powdered plain gelatine in an ounce of hot water.



3. In a darkroom make a silver bromide solution as explained above.



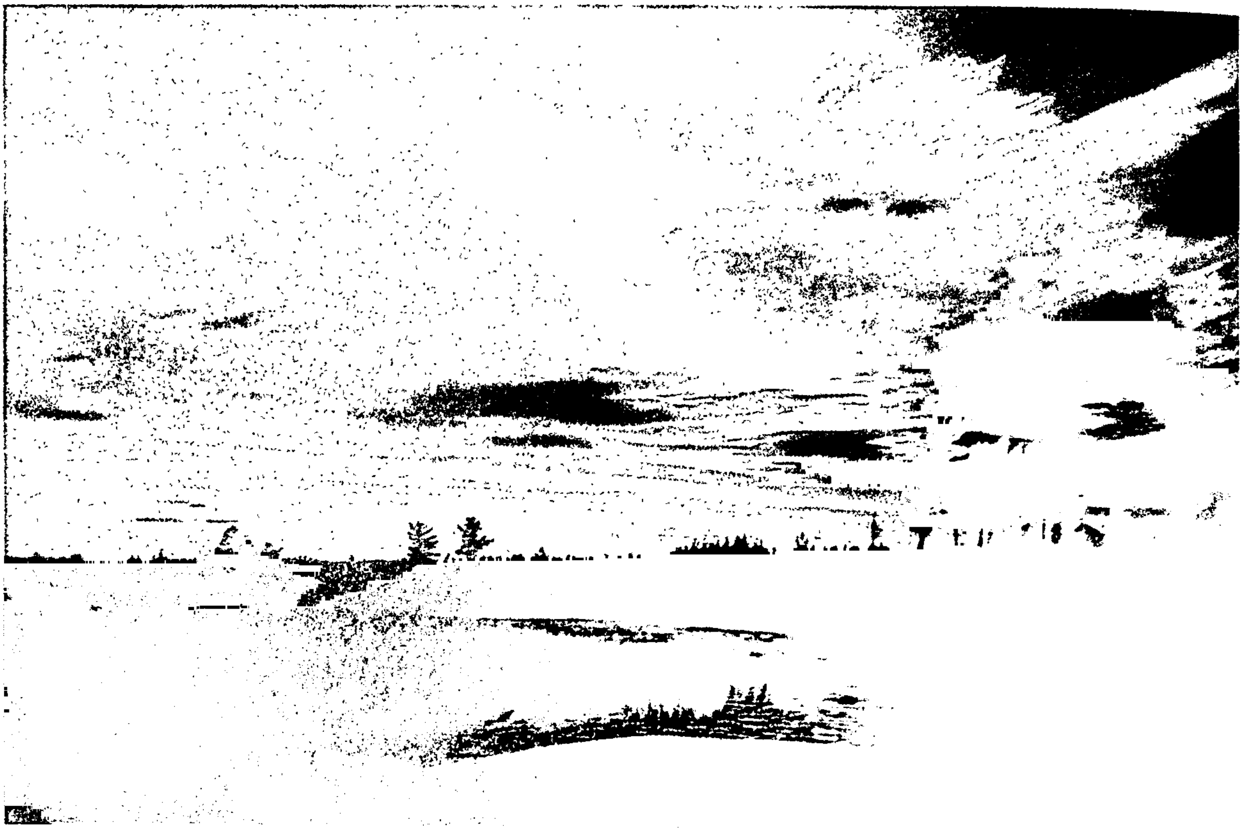
4. Add the solution to the gelatin to make an emulsion.

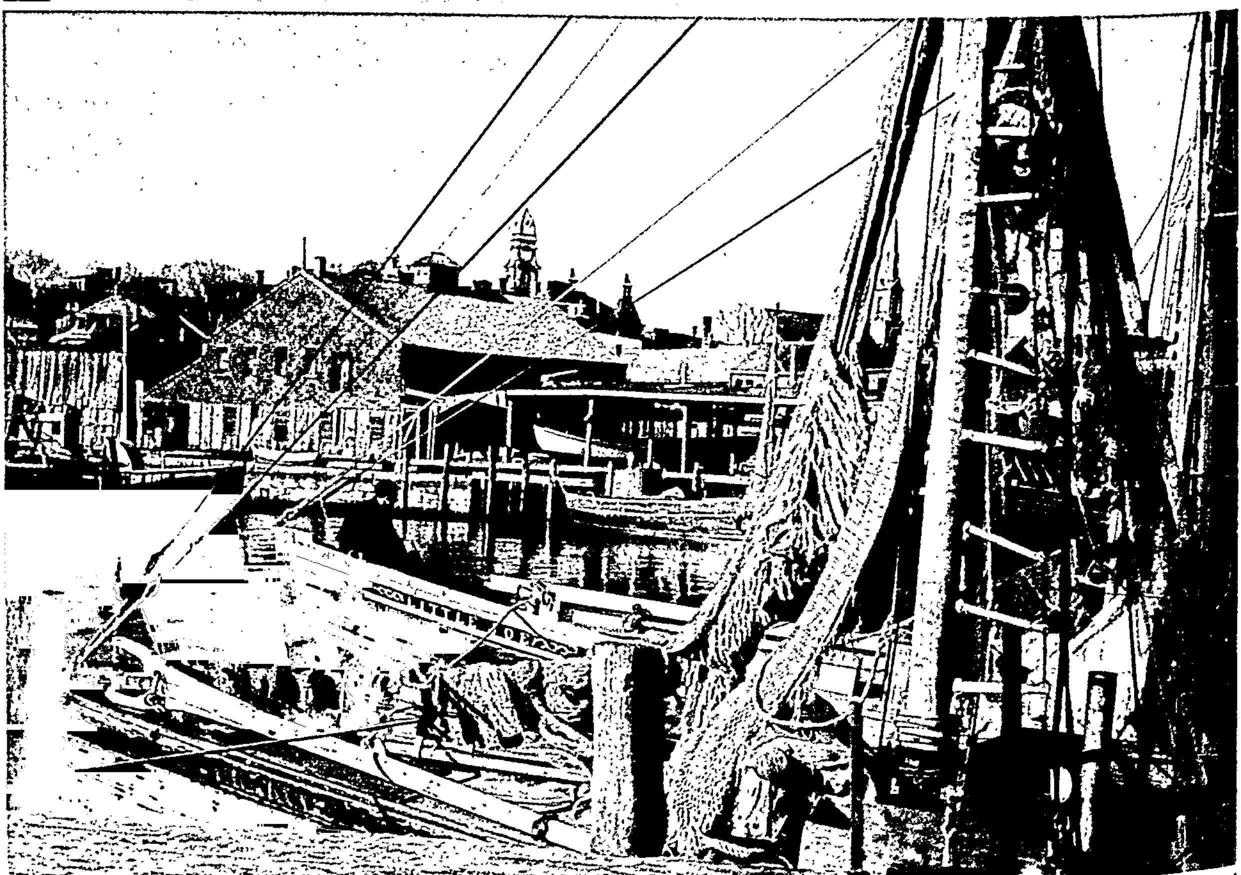
5. Flow the emulsion on the glass or celluloid. Keep it dust free. When the gelatin hardens, the plate will be coated with a light-sensitive emulsion.

Direct-color photograph *By John Kabel*

AN EXAMPLE OF DIRECT-COLOR PHOTOGRAPHY

The invention and production of kodachrome film in the late 1930's greatly improved the quality and flexibility of color photography. It became possible for good photographers to make pictures like this one as easily and with the same equipment as they had formerly made black-and-white photographs.





Direct-color photographs *By John Kabel*

THE WIDE RANGE OF COLOR PHOTOGRAPHY

These pictures demonstrate the extreme flexibility of modern direct-color techniques. Above is a scene expressing poetic feeling without realistic detail in a manner that parallels the work of such painters as Inness and Ryder. Below, we see the very opposite—a view of a New England fishing harbor where beauty and interest are created by the wealth and precision of detail.

Working Principles of Photography

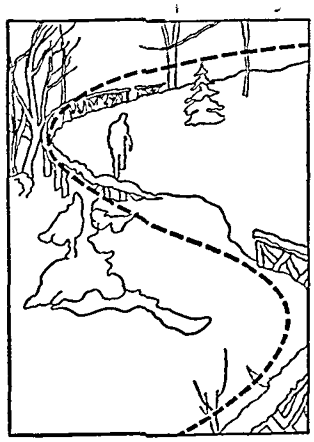
TO RECORD the image formed by a camera, photography uses a compound of silver with one of the halogen elements—bromine, chlorine, or iodine. These *halide* salts break down when struck by light. Silver bromide is most commonly used.

The silver salt is mixed with gelatin to form an emulsion, and the emulsion is spread thinly on a sheet of transparent material. Glass, cellulose acetate, and cellulose nitrate are all used as bases. A piece of coated glass is called a *plate*; the other substances make *film*. A light-sensitive film or plate must be kept in darkness until it is exposed in the camera.

How Light Makes an Image

When the photographer clicks the camera shutter open, light from the subject flashes through the lens and strikes the coating of the film. During this exposure, the sensitive salt breaks down wherever the light strikes. The result, as shown on a preceding page, is a deposit of metallic silver in minute grains. The stronger the light, the more grains are deposited. Thus the salt registers every detail of brightness and shadow in the subject.

The film cannot be exposed to more light as yet, because more of the salt would break down and obliterate the image. To prevent this, the photographer must *develop* the film by chemical action.



How Developing Fixes the Image

To start development, the photographer transfers the plate or film to a tray or tank in a darkroom. Sensitive panchromatic films must be developed in a light-tight tank or in a completely dark room. Less sensitive types of films may be exposed to special colored light without harm. If the photographer uses trays in developing such types of films, he can watch the development proceed

First he covers the film with a solution of *developer*. The most common developers are hydroquinone, metol, and trihydroxybenzene. Each one takes free bromine into solution and leaves free silver behind.

When development starts, the film has a blank yellowish coating. The image has been recorded but is still *latent*. Soon dark patches appear wherever the film was struck by the most intense light. In those high lights the silver salt has broken down most completely, and the developer leaves a thick deposit of silver grains. Next, less dense patches appear; but on parts that correspond to dark areas of the subject, the yellowish coating with some unchanged silver salt remains.

Then the photographer removes all the unchanged silver salt by washing to remove all the developer and placing the film in a solution called a *fixer*. The most common fixing chemical is sodium thiosulphate. Photographers call it "hypo," because at one time it was thought to be hyposulphite of sodium.

Simplicity is the key to making good photographs. In this snow scene one simple curved line dominates the composition, as demonstrated by the inset drawing. Dark masses are nicely balanced.

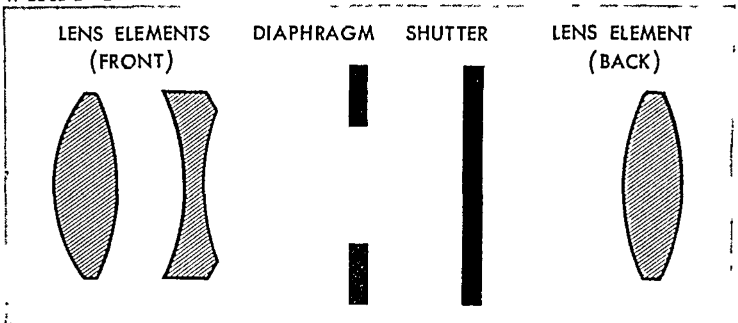
The fixer dissolves all the unchanged silver salts. Thereafter the film can be exposed freely to light. The deposits of silver grains will not change. Finally the photographer washes the film thoroughly in running water and lets it dry for several hours.

This sequence of operations explains why the developed film is a *negative*. Bright parts of the subject cause dense, dark deposits of silver, and dark parts produce slight deposits. These values are reversed again in the *positive* print. Transparent parts of the negative (dark parts of the subject) let light pass freely and form heavy deposits on the printing paper. Denser parts transmit less light, and corresponding parts of the print will look light. Thus the values in the print are those of the original subject.

Work of the Lens, Shutter, and Diaphragm

This chemical process will give a satisfactory result only if the emulsion receives the right amount of light in proper focus. To accomplish this, the camera has a lens, a shutter, and a diaphragm. The lens gathers light and brings it to a focus. The shutter admits light for exposures and keeps it out otherwise. The diaphragm controls the size of the opening through which the light enters.

WHAT IS INSIDE A GOOD PHOTOGRAPHIC LENS

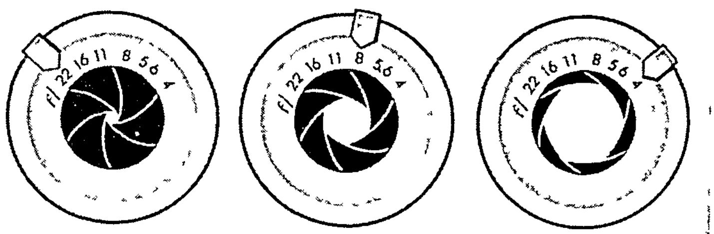


The three lens elements of the anastigmat together form a clearer image than any single lens. The diaphragm and shutter lie within the lens itself. In a real lens the various parts are closer together than shown here.

In cameras, the commonest lenses are the *meniscus*, the *doublet*, and the *anastigmat*. The meniscus is a dish-shaped lens. It has serious aberrations and is used in cheap cameras only. The doublet is two meniscus lenses with the concave sides together. It gives partial correction of aberrations (*see* Lens).

All fine cameras have anastigmatic lenses. These lenses are free from astigmatism (failure to bring slanting and direct rays to focus at the same point). These lenses eliminate most of the errors of refraction by using three or more *elements* (separate lenses). Each element has aberrations, but every aberration in each one is canceled by an opposite aberration in one of the others.

PART OF THE CAMERA'S EYE



Like the iris of our own eye, the diaphragm can be enlarged or contracted to give adjustment to different light conditions. Its many leaves are pivoted at the edge. Turning together, they widen or reduce the aperture. When light is dim, the diaphragm must be opened wide; in bright light it can be closed down.

Lenses are frequently classified by *focal length*. This term means the distance between the optical center of the lens and the emulsion when the camera is focused on a far-distant object. A miniature ("candid") camera may have a lens of only two-inch focal length while a studio camera may have a focal length of 15 or 20 inches.

How the Shutter Makes Exposures

The shutter on a camera admits light for exposures. On all but the cheapest camera, the photographer has a choice of exposure times. For instantaneous exposures the times are from one second to as little as $\frac{1}{1250}$ of a second on some fine cameras.

For longer exposures, the photographer uses the "time" (T) setting or one marked B for "bulb." This name came from a type of release which the photographer worked by squeezing a bulb on the end of a tube. It is misleading, for two reasons. Most amateur cameras with extension releases use a cable which is moved inside a cover by touching a plunger at the end. And both the T and B exposures can be worked with the regular trigger release on the lens mounting. The true distinction is this: for a T exposure, the photographer touches the trigger or cable plunger *once* to open the shutter and *again* to close it. For a B exposure he presses on the trigger or plunger as long as he wants the shutter open and lets go to close it.

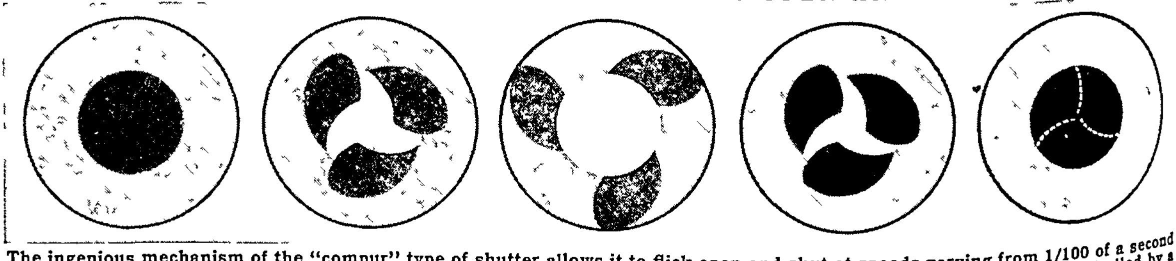
The commonest type of shutter is mounted between the elements of the lens, as shown in pictures on this page. Some cameras have *focal plane* shutters. This device is essentially a curtain mounted just in front of the film—that is, in the focal plane. The curtain has a slit, and the shutter makes exposures by sweeping the slit across the film.

Shutters are spring driven, and speed is regulated by adjusting the spring tension. Many cameras also have a regulating gear train. In focal plane shutters, the width of the slit and the speed of its travel across the film can be varied to regulate the exposure time.

The Diaphragm and F-Number

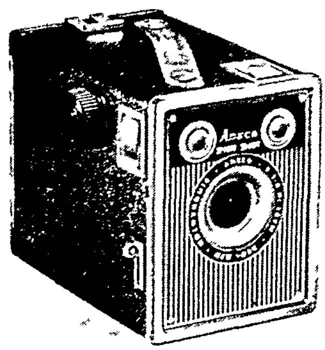
The diaphragm works to regulate the amount of light which enters the camera at any given instant as shown in pictures on this page. On most cameras the widths of aperture are indicated by numbers marked f/. Each number is equal to the focal length of the lens divided by the width of the aperture. Cameras

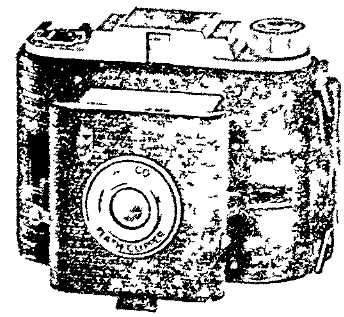
HOW THE CAMERA SHUTTER WINKS OPEN AND SHUT

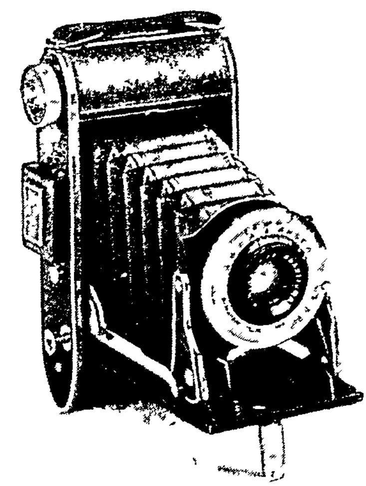


The ingenious mechanism of the "compur" type of shutter allows it to flick open and shut at speeds varying from 1/100 of a second or less up to one second. The shutter consists of three overlapping leaves pivoted at their outer edges. Speeds are controlled by a variable-tension spring and usually also by an inertia retarding mechanism.

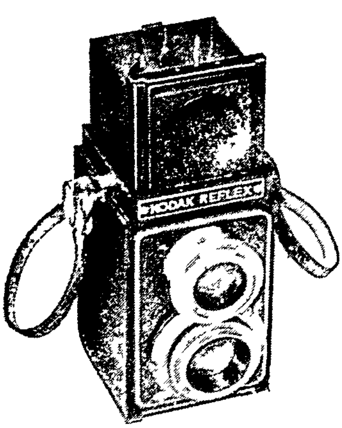
AN IMPRESSIVE ARRAY OF AMERICAN-MADE CAMERAS

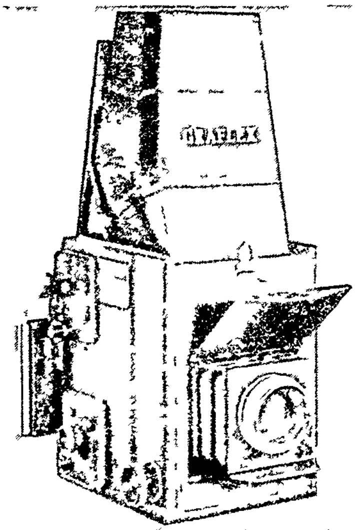


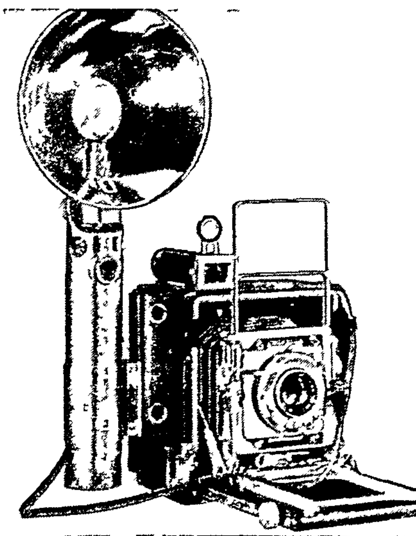




Most amateurs start taking pictures with one of these three types of cameras. From left to right they are a box camera, a simple folding camera, and a good folding camera. The box camera and the simple folding camera have single meniscus lenses with fixed focus. The other folding camera mounts an anastigmatic lens.



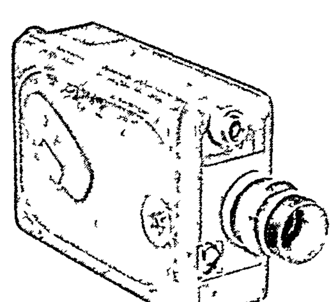


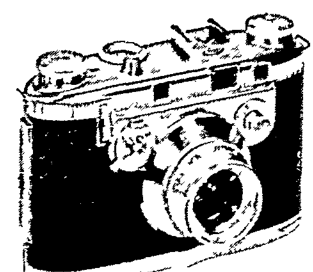


A ground glass viewing screen in these three cameras helps greatly in composing a picture. The photographer sees his picture at the same size as the finished print. At the left are two reflex cameras, the larger has a focal plane shutter. The press camera at the right has an auxiliary open finder for fast work, two types of shutters, and a built-in flash synchronizer.

vary in the numbers shown, but usually they are selected so that the setting at any number admits half as much light as the setting at the next lower number.

Cameras have a diaphragm as well as a shutter to help the photographer meet different conditions of light intensity. He can do so by varying either the time of exposure or the size of the diaphragm opening; but often there is little choice for exposure time. To "stop" an athlete in action—that is, get a picture without any blur of motion—an extremely short exposure must be used. The photographer therefore makes allowance for light intensity by opening the diaphragm accordingly.





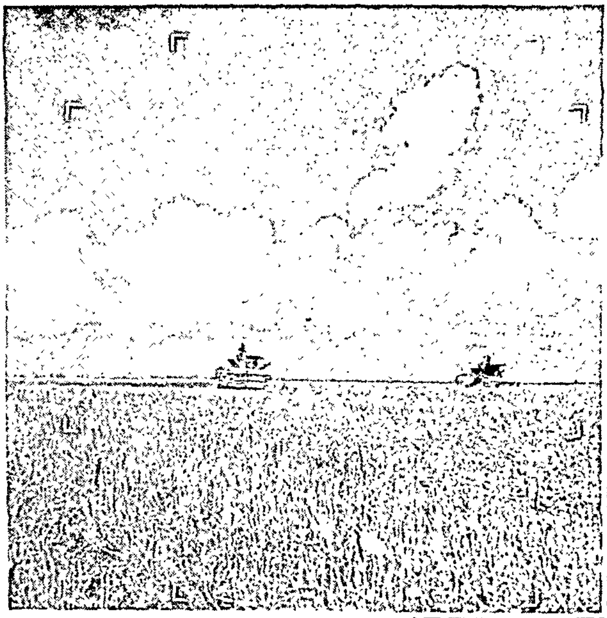
The cartridge-loading 16-millimeter camera at the left takes excellent motion pictures in color or black and white. The fine 35-millimeter still camera at the right has the best lens and mechanical parts that can be manufactured.

For motionless subjects he may choose a small aperture, for a good reason. The lens will then have greater *depth of field*. This means that objects closer to the lens and farther away will be brought to good focus. Therefore the photographer may "stop down" the diaphragm and choose an exposure time that suits the light and the small aperture.

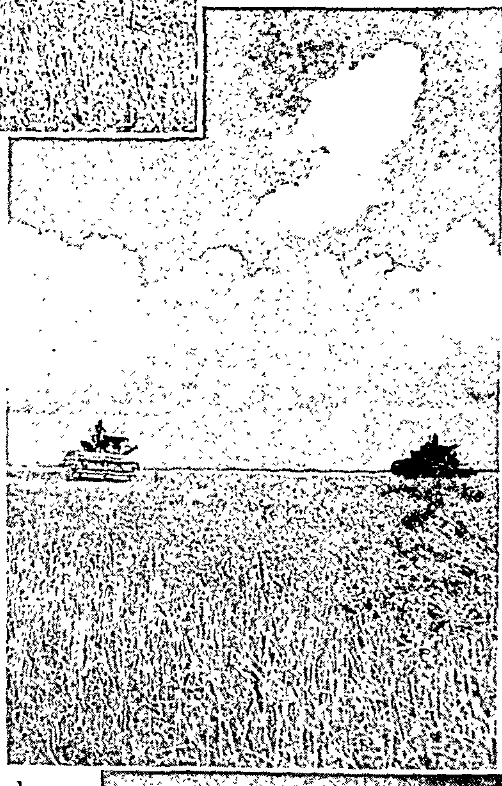
Choosing a Camera and Accessories

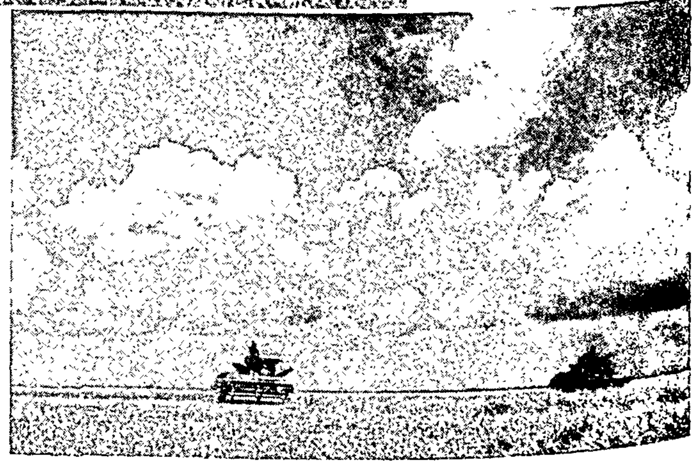
Cameras vary endlessly in construction and quality as well as in price; but they may be classified within a few general types. Most of these are illustrated here.

CROPPING A PICTURE IN DIFFERENT WAYS



The picture above is an entirely satisfactory composition of a harvesting scene. But notice how two other pictures of different proportions and different feeling can be made by cropping. White marks show the portions used for the lower pictures.





The first accessories an amateur would want might include a tripod, an exposure meter, and a K-2 filter. A tripod is necessary for exposures longer than about 1/10 of a second. An exposure meter (also called light meter) helps in estimating the amount of illumination on a subject and computing the proper exposure. In color work, exposure meters are particularly valuable because exposures must be exact. A filter, when placed in front of the camera lens, screens out certain colors in the light reflected by the subject. Film is particularly sensitive to violet and ultraviolet, which the sky reflects in abundance, giving a dense negative and a washed-out look in the print. The yellow K-2 screens these out and gives the sky a more natural appearance. Many other filters for special purposes are also available. If the amateur has a camera with interchangeable lenses, he may also want to get one or more special lenses. The most useful are a *telephoto*, for long-distance work, and a *wide-angle* lens for short-range work.

Films for Different Kinds of Work

Films are made in a wide range of working qualities. The difference is in the use of more or less sensitive silver salts and varying other ingredients of the emulsion. The most fundamental difference is between film for black-and-white work, and film for pictures in color.

Black-and-white film is made in two great types—*orthochromatic* and *panchromatic*. They vary in their sensitivity to the different colors which make up "white" light (*see* Spectrum). Orthochromatic film is sensitive to color from ultraviolet through green. Panchromatic film is sensitive to all colors, although it reacts somewhat weakly toward red. One special type of film is sensitive to infrared radiation and is used in "black light" photography.

Film is made in a wide range of speeds. Fast film records an image in only a fraction of the time required by slower films. Emulsions vary also in *latitude*, *grain*, and *contrast*. A wide-latitude film takes bright and shadowed parts of a subject equally well. A narrow-latitude film will favor one or the other. Graininess depends on the extent to which the silver grains clump together in development. The amount of grain sets a limit to possible enlargement. Fast film tends to be grainier than slow film. If greatly enlarged prints are desired, the negative should be made with slow, fine-grain film. High-contrast film emphasizes the difference between light and dark portions of a subject while low-contrast film subdues the differences.

Color film is not only sensitive to all colors; it reproduces them instead of reducing them to black and white. It uses a variant of the three-color process used in printing. The film has three layers, each sensitive to a certain color, and a filter which registers that color from the total light.

During development, each layer becomes stained with its color. When the film is viewed by transmitted light, the colors "mix" to give a total colored effect, as explained in the article on Color.

Photographic print papers are made much as film is, with an emulsion on a paper base. All print papers are orthochromatic. Otherwise they have a wide range of working qualities and surface. The most commonly used paper has a glossy surface which emphasizes detail. Matte-finished paper has a velvety surface and no sheen. Papers can be bought that print out in tones from blue-black to chocolate brown.

Taking Motion Pictures

Amateur motion-picture taking avoids most problems about materials and developing, since all processing is done professionally. The task becomes simply that of taking good pictures, and depends upon the fundamentals of choosing interesting subjects, getting good composition, and gauging exposures exactly.

The matter of interest is something which each person naturally settles to suit himself. Beginners can afford to remember, however, that distant and medium scenes soon become tiresome, if not interspersed with interesting closeups. Panoramic surveys must be taken with a slow swing and a steady hand to avoid getting a picture that jerks and sweeps across the screen. The remaining problem of good composition is one that never ends. A photographer who gets really good pictures will give much more time to studying "angles" and estimating carefully what his pictures will contain than he does to taking it. Here is where the difference between the beginner and the truly skilled photographer becomes evident. This is the point at which the photographer becomes an artist.

The Many Men Who Developed Photography

GENERALLY 1839 is considered the year when photography was born. In that year Louis Daguerre of Paris, France, made public his photographic process. But photography actually grew from a number of achievements, and no specific date can be given for the invention.

A beginning was made many years before Daguerre's time. The *camera obscura* was known since ancient Greek times (*see* Camera). A simple form was like a pinhole camera with a translucent screen. It was used for copying brightly lighted objects.

It had been known that silver nitrate turned dark with the passage of time. In 1727 a German scientist, Johann Heinrich Schulze, demonstrated that this was caused by the action of light. In England 75 years later, Thomas Wedgwood (son of the famous potter) and Sir Humphry Davy used silver nitrate to produce silhouettes on glass. But these pictures faded quickly unless they were kept in the dark.

A DAGUERREOTYPE PORTRAIT

Stiff little daguerreotypes were the ancestors of photographs. But these old pictures often show finer detail than modern photographs. In the original of this picture, the wrinkles on the woman's hands and the printing on the book cover are clearly visible.

The Beginnings of True Photography

In the early 1800's Joseph Nicéphore Niépce of France tried to discover some way to impose images on lithographic stone without the aid of an artist (*see* Lithography). He finally did so with bitumen and oil of lavender. Bitumen, a resinous substance, ordinarily dissolves in oil of lavender, but after exposure to light it becomes insoluble. In about 1826 Niépce used a similar method to produce on a pewter plate an image formed by a camera obscura. This was the first true—that is, permanent—photograph ever made. Niépce's process did not lead directly to modern photography; therefore historians do not consider his achievement the birth of this science.

Daguerre and the Daguerreotype

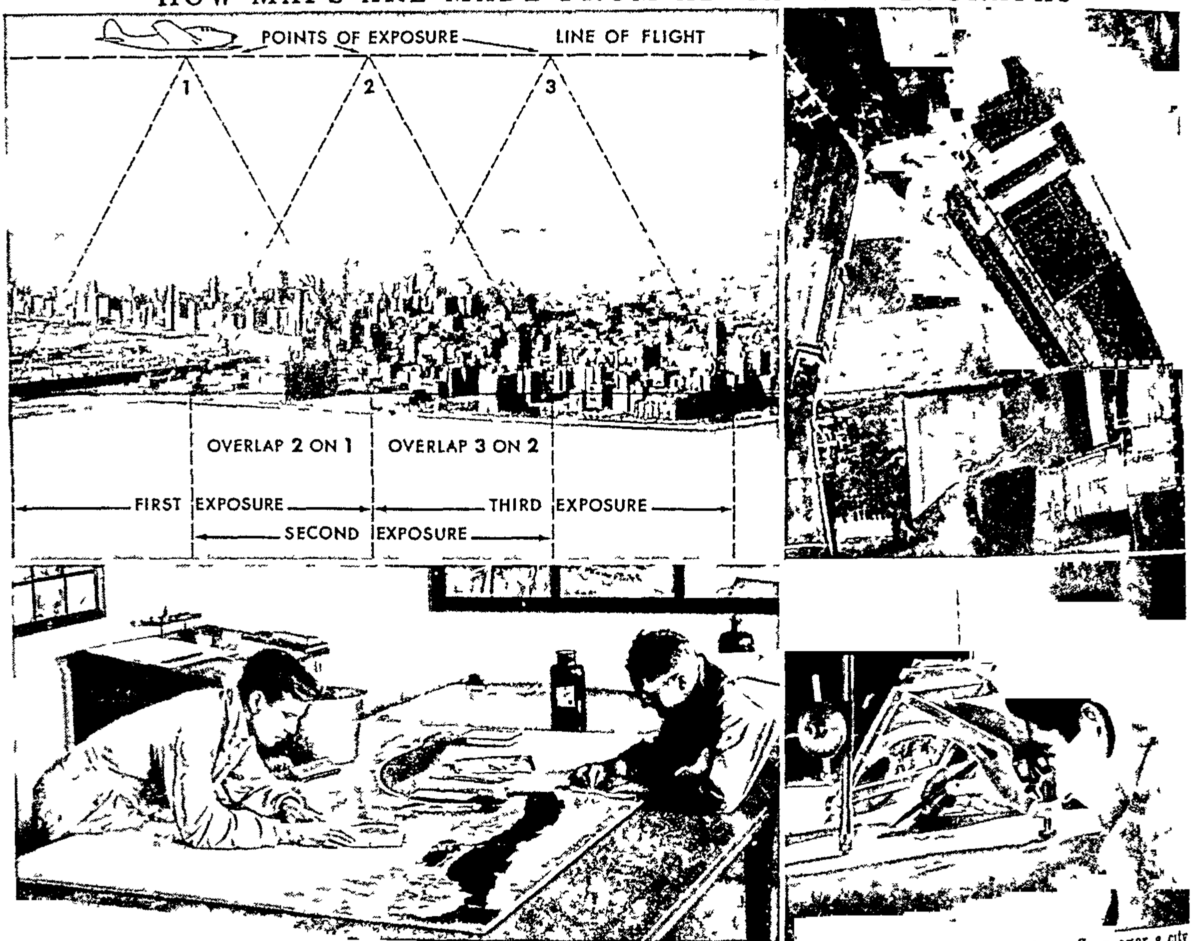
Meanwhile, Louis Daguerre, a French artist, was experimenting with images formed with silver salts. Hearing of Niépce's work, he communicated with him, and in 1829 they became partners. During the next few years Daguerre, with Niépce's help, worked out the process later known as *daguerreotypy*.

His process was relatively simple. A silver-plated sheet of copper was fumed in iodine vapor, which formed a coating of silver iodide. Next it was exposed in a camera and then developed in the fumes from boiling mercury. Mercury adhered to the light-struck parts of the plate, giving it a shiny appearance. Finally the plate was fixed in hypo. Daguerreotypes became immensely popular and established photography firmly as an art.

Talbot and the Calotype Process

The daguerreotype had one serious drawback. No copies could be made from it. This difficulty was overcome in England. In Daguerre's time an Englishman, Henry Fox Talbot, developed a method for impregnating paper with silver chloride. When exposed in the camera, the sensitized paper blackened where light struck it, and so the image did

HOW MAPS ARE MADE FROM AERIAL PHOTOGRAPHS



These pictures show various steps in making maps from aerial photographs. Upper left, we see how a plane flies over a city and makes several exposures with a special aerial camera. Each picture broadly overlaps the other so that no part of the city will be missed. Upper right, we see a map made by joining two aerial photographs. Rivers, roads, and fields stand out plainly. The dotted line shows where the two pictures were joined. Lower left, we see soldiers pasting many aerial photographs on a board to make a large, comprehensive military map. Lower right, a soldier uses a device similar to the *camera lucida*, described in the article on Camera. He is taking details from an aerial photograph to make a simple field map.

not need to be developed. It was fixed in hypo, an operation suggested to Talbot by the scientist Sir John Herschel. To get positive prints, Talbot made his paper negative more nearly transparent by waxing it. Then he could make any number of contact prints on the same kind of paper.

Talbot patented his method under the name *calotype* in 1841. Calotypy never became as popular as daguerreotypy, but most later methods of photography have been developed from Talbot's work.

The End of the Daguerreotype Era

Two new photographic processes were announced early in the 1850's. In 1851 Frederick Scott Archer, an English sculptor interested in photography, made public his *collodion* process (also called the *wet-plate* process). He used a glass plate coated with collodion as a base for the silver salt. This photographic plate was quite sensitive as long as it remained damp, but after it dried it lost its sensitivity. So a plate had to be prepared and exposed in as short a time as possible, preferably only a few minutes. Despite the inconveniences of the wet-plate process, it was simpler and more dependable than any other then in use.

Another photographic process, the *ambrotype*, was patented by an American, James A. Cutting, in 1854. The ambrotype was a thin collodion negative on glass. When backed with some black material, usually velvet, it gave the appearance of a positive image. The *tin-type*, patented two years later by another American, Hamilton L. Smith, was an ambrotype made directly on black japanned metal.

Dry-Plate Photography

In 1871 an amateur English photographer, Dr. R L Maddox produced a successful *dry plate*. He suspended light-sensitive salts in gelatin and flowed the emulsion on glass. His plates were slow, but they were improved and in time they replaced the older wet plates.

An American photographer, George Eastman, patented flexible roll film in 1884. His film was paper-backed, and to print a negative, the emulsion had to be stripped from the paper and mounted on glass. Four years later, Eastman produced the first of his roll-film cameras, for which he coined the name "Kodak."

The first good transparent roll film was probably invented by the Reverend Hannibal Goodwin. As an amateur photographer he developed a method of

coating a base of cellulose nitrate with gelatin emulsion. His patent was filed in 1887 but was not granted until 1898, and litigation over conflicting claims did not come to an end until 1914.

Few basic improvements have been made in black-and-white photography since the 1880's, although films, plates, and printing papers have been vastly improved and made more sensitive, and new equipment has been developed. Efforts to achieve color photography accompanied the long rise of black-and-white work. In the 1930's good color film became available to amateurs. Today several varieties are sold.

The Uses of Photography

Besides portrait and amateur work, photography is used to record what many scientific instruments "see." The telescope, the spectroscope, the microscope, the X-ray machine, and the electrocardiograph are only a few of these. In surveying and mapping, photography is a valuable tool. Accurate maps and contour charts are now often drawn from photographs made on the ground or from the air.

In libraries, *microfilm* records are supplanting newspaper files, and banks use film to record checks. *Photostats* of documents are made by a machine that produces these photographic copies automatically.

Some cameras used by scientists employ an electronically controlled flash to give a brief, intense illumination. One ultra-high-speed camera of this type can take 10 million frames a second.

One camera for amateur photographers carries its own developing and printing chemicals. Within a minute after taking a picture, the camera produces a developed print. Other cameras use stereoscopic principles (*see* Stereoscope). They take two simultaneous pictures of the same field. By means of a stereoscopic viewer or projector, the two images blend into one that seems to have three dimensions. Three-dimensional ("3-D") motion pictures employ polarized light to separate the images (*see* Light).

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PHRENOL'OGY. Phrenology is one of the *pseudo* (false) sciences that claim to provide a quick and reliable method of reading character. Astrologers base their readings on the stars, graphologists on handwriting, numerologists on names, physiognomists on the face, and palmists on the hand. Phrenologists claim that character is revealed by the size and shape of the skull.

The founder of phrenology was Franz Joseph Gall (1758–1820), a German physician. He charted on the skull 26 sections and claimed that the part of the brain under each section controlled a specific "faculty," such as veneration, firmness, language ability, or destructiveness. A bump or depression in a particular spot was supposed to indicate that a certain faculty was strong or weak. Since Gall's time, psychologists, surgeons, and anatomists have furnished a correct view of brain functions (*see* Brain). Phrenology, like the other pseudo sciences, has no scientific foundation. Yet even today many people pay large sums of money to phrenologists and other character readers for advice on such important matters as marriage or choosing a career.

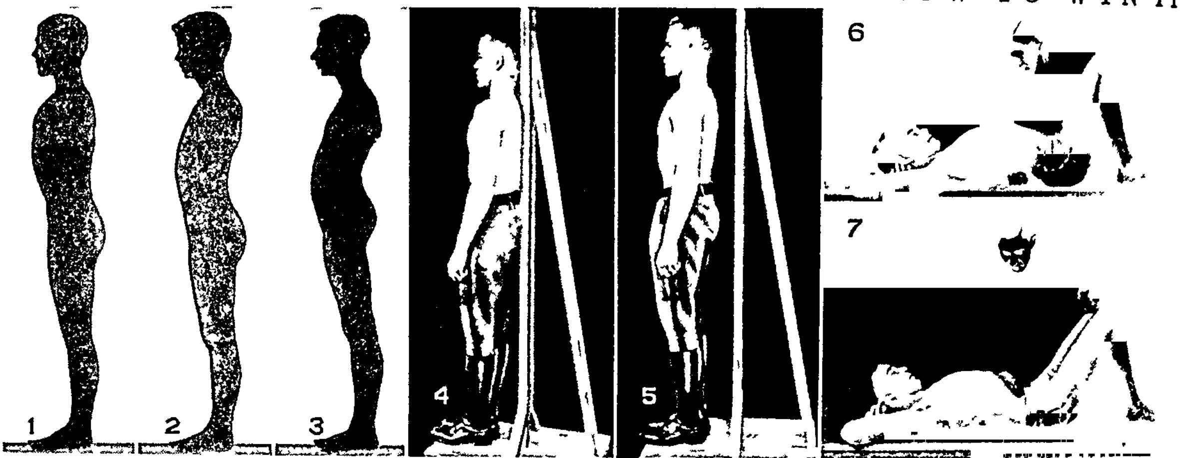
PHYSICAL EDUCATION. In pioneer days people maintained their health and strength without a thought of special exercise; but now conditions are changed. Physical education does not attempt to produce trained athletes, for too much exertion is sometimes as dangerous as none; but it does aim to produce and retain normal health for those whose lives are largely sedentary.

Many exercises can be performed anywhere without gymnastic equipment; but fresh air is always important. Such exercises should be practiced daily and at regular times if possible, but never within two hours after eating or one-half hour before. The best times are 10 to 12 in the forenoon or 4 to 6 in the afternoon. Very good results may be obtained by practicing for 15 minutes in the morning before breakfast. Gentle exercises may also be taken with benefit at night before going to bed. Violent exercise at night is likely to cause sleeplessness.

Gymnastics differ from such setting-up exercises in being performed with the aid of special kinds of apparatus. Light gymnastics include such exercises as are performed with light pieces of portable apparatus, such as dumbbells, Indian clubs, wands, hand rings, and balls. Heavy gymnastics include those performed with horizontal and parallel bars, ladders, vaulting horses, suspended ropes, poles, rings, and trapeze bars, where the weight of the body is supported and made to move or revolve about the apparatus by aid of the hands or legs. Work with special apparatus is of particular value to persons who, on the advice of a physician, wish to take some form of corrective gymnastics.

Better than setting-up exercises and gymnastics, however, are games played in the open air (*see* Baseball; Football; Golf; Tennis; etc.), and such outdoor sports as running, bicycling, jumping, pole vaulting, swimming, and skating.

POINTERS ON CORRECT POSTURE AND HOW TO WIN IT



Proper posture is shown in the shadow picture 1 rated A at Culver Military Academy. Poor posture is shown in 2 and 3—head too far forward, chest not up enough, stomach sagging, back swayed. How can one be sure of having proper posture? Stand like the boy in 4, with heels several inches from the wall; buttocks, shoulders, and head against the wall; chin up; and chest in. Then shove away from the wall with one hand without changing the position of the body, as shown in 5. In 6 the boy has a sway back so hollow that the instructor can place his fist between it and the table. As a corrective exercise, the boy in 7 lies flat on the table, raises his knees, and pushes his hips down toward his heels.

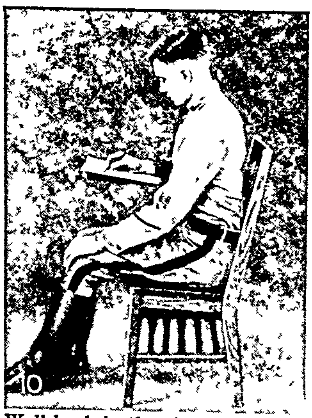
In recent years a great deal of attention has been given to the study of posture not only for the sake of appearance but for the sake of health and efficiency. Good posture is essential to proper adjustment, physical and mental. Poor posture cramps the vital organs, hastens fatigue, and stores up body poisons.

The boy in 8 has the proper rib spread, with room for heart and lung action. Room for four fingers at the apex where the ribs join is the test. A narrow rib spread may be broadened as in 9 by pulling the ribs outwards while inhaling and keeping the hold while exhaling. Repeat 10 times.

To stand properly and easily you should relax your knee muscles enough to avoid strain and rest the weight of the body firmly on both feet. The abdominal muscles should be held firm, the chest up (but not enough to cause the lower back to curve greatly), the shoulders relaxed, and the head erect.

In walking, the same general rules for posture hold. One should walk with the toes straight ahead and with the feet flexible in comfortable shoes.

In sitting, one should be well back in the chair, with both feet squarely on the floor. The upper back and neck should not bend; one should bend forward from the hip joints. Sitting without change for a long time is tiring and causes slumping.



Well back in the chair, back and waist straight, chest up, the youth in 10 is sitting correctly. His feet also are square on the floor.

Look over a group of people in gymnasium or bathing suits. Note the number with flat hollow chests, sagging stomachs, round humping shoulders, hollow or sway backs, or droopy heads. Some of them doubtless have fallen arches and stiff tense knees, posture defects which are less noticeable but are no less common and serious. Notice too how awkward these same people appear, as compared to the few who know how to carry themselves properly.

Corrective Exercises

Physical training and corrective gymnastics do much to improve faulty posture. Many games played in the open air and such outdoor sports as running, bicycling, jumping, pole-vaulting, swimming, and skating are also valuable as aids to correct posture.

Most schools give exercises and training in correct posture. The pupil is taught to maintain a good position while standing, while marching, and during exercise. Directions and tests are given to encourage this habit and to point out defects.

Posture defects once firmly established do not yield readily to corrective treatment. Therefore, the essentials to good posture, such as strong bones, firm and well-coordinated muscles, and proper social adjustments need consideration from earliest childhood. A feeling of self-confidence, courage, determination, and good cheer does more to influence poise and excellent carriage than do mere mechanical drills. And correct posture will definitely increase a person's feeling of well-being.

High-voltage discharges of artificial lightning are used in this laboratory to test protective equipment for electric power lines. This is one of many ways in which physics helps man to harness natural forces.

How PHYSICS *Helps Man to* HARNESS *Nature*

PHYSICS. Without the science of physics and the work of physicists, our modern ways of living would not exist. Instead of brilliant, steady electric light, we would have to read by the light of candles, oil lamps, or at best, flickering gaslight. We might have crude railroad locomotives and steamships, but we could not have the highly developed and tremendously powerful machines we do. We might have buildings several stories high, but there could be no hope of erecting an Empire State Building. We could not possibly bridge the Hudson River or the Golden Gate much less build a jet plane, talk on the telephone from New York to London, or watch a television show.

All other natural sciences depend upon physics for the foundations of their knowledge. Physics holds this key position because it is concerned with the most fundamental aspects of matter and energy and how they interact to make the physical universe work. For example, modern physics has discovered how atoms are made up of smaller particles and how these particles interact to join atoms into molecules and larger masses of matter. Chemists use this knowledge to guide them in their work in studying all existing chemical compounds and in making new ones.

Biologists and medical men in turn use both physics and chemistry in studying living tissues and in developing new drugs and treatments. Furthermore their electrical equipment, microscopes, X rays, and many other aids and the use of radioactivity were developed originally by physicists.

Physicists have also led in bringing man to think in scientific ways. What we call the "scientific method" had its real beginnings some four centuries ago in many fields of knowledge. The most impressive of the early triumphs came in physics and in the application of physics to astronomy for studying the apparent and real motions of the sun, the moon, the planets, and the stars.

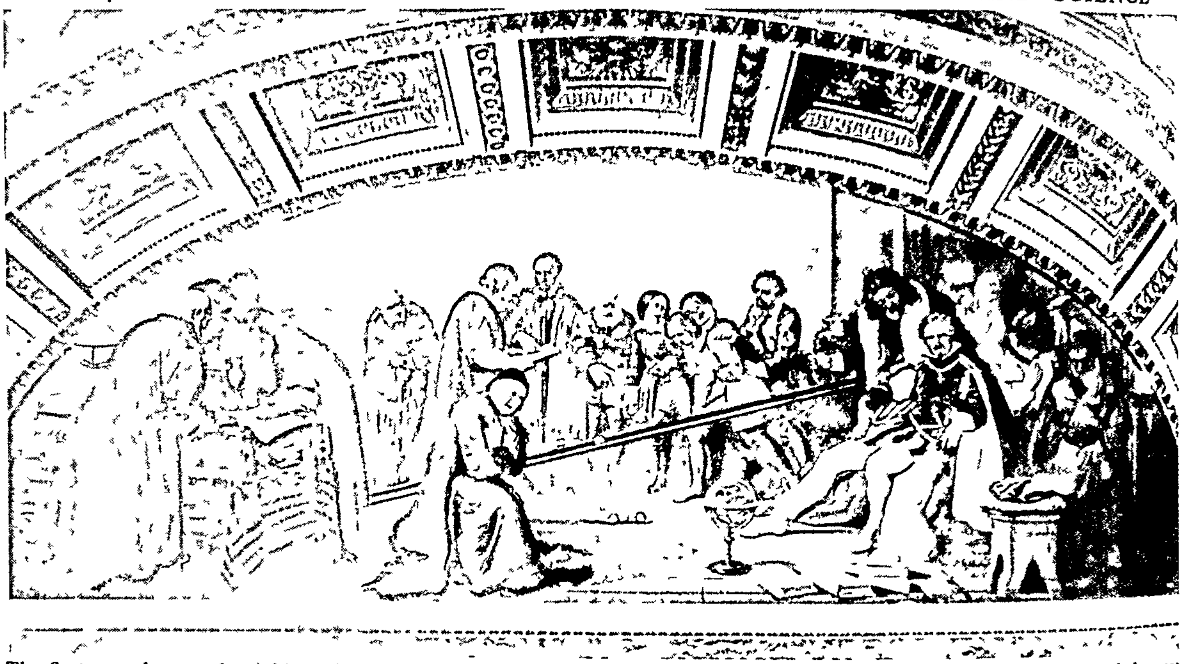
Galileo made the first real contribution by discovering the natural laws which govern falling bodies and the swinging of the pendulum. Then Kepler established the three laws which explain all the motions of the planets. Finally, Newton verified these results by establishing the law of gravitation, which applies invariably to all matter in the universe—as small as a grain of sand or as large as the sun.

This triumph of explaining a vast range of phenomena with a single law inspired workers in all fields of knowledge to trust scientific methods in seeking new knowledge. Galileo, Kepler, and Newton also made important contributions to the development of telescopes and thus gave astronomy a powerful instrument to work with.

The Many Divisions of Physics

There is no exact distinction between physics and other natural sciences because all sciences overlap. In general, however, physics deals with phenomena

EXPERIMENTS THAT GAVE BIRTH TO MODERN PHYSICS AND SCIENCE



The first experiments that laid the foundations for the scientific method are often said to be those performed by Galileo to discover the law of falling bodies. He worked out his results for accelerated motion by timing balls as they rolled down an inclined plane. Here he is demonstrating his method before a group of dignitaries and scholars. Many of the scholars are shocked by Galileo's assertion that if the experiments contradict what is said by authorities such as Aristotle, then Aristotle must be wrong. The picture is from a fresco by Guiseppe Bezzuoli in the Museum of Natural History in Florence, Italy

which pertain to all classes of matter alike or to large classes of matter as long as they remain free of chemical change.

One major subdivision of physics deals with the *states* of matter—solids, liquids, and gases—and with their motions. The pioneer achievements of Galileo, Kepler, and Newton dealt with solid masses of matter in motion. Such studies are a part of the subject of *mechanics* and belong to the subdivision of mechanics called *dynamics*, the study of matter in motion. This large topic includes not only the motions of stars and baseballs but also those of gyroscopes, of the water pumped by a fire engine (*hydrodynamics*), and of the air passing over the wings and through the jet engine of an airplane (*aerodynamics*).

The other great subdivision of mechanics is *statics*, the study of matter at rest. Statics deals with the balancing of forces with appropriate resistances to keep matter at rest. The design of buildings and of bridges are examples of problems in statics.

Other divisions of physics are based on the different kinds of energy which interact with matter. They deal with *electricity* and *magnetism, heat, light,* and *sound*. From these branches of physics have come clues which have revealed how atoms are constructed and how they react to various kinds of energy. This knowledge is often called the basis of *modern physics*. Among the many subdivisions of modern physics are *electronics* and *nuclear physics*.

Physics is intimately related to *engineering*. A person who uses physical principles in solving everyday problems is often called an *engineer*. For example, electricity is one of the subdivisions of physics; a man who uses the "natural laws" of electricity to help in designing an electric generator is called an *electrical engineer*.

Scientific Methods Used in Physics

Physics attempts to describe and explain everything that happens in the physical universe. Physicists therefore try to discover one or more "laws" (meaning invariable principles of nature at work) which will explain a large class of phenomena. Newton's *law of gravitation* is a fine example. Another is the law of mirrors—"the angle of incidence is equal to the angle of reflection."

Physicists express these laws in some exact mathematical form, which can serve later as a basis for measurements and calculations. For example, Newton's law of gravitation states that the force of gravitational attraction (F_g) between two separate masses depends, first, upon the amount of mass (m) in each one, and second, upon the distance (d) between the masses. The masses must be multiplied together, and the pull diminishes with the *square* of the distance. If the distance is doubled, the pull is only one fourth as great. The whole law can be stated in the short formula: $F_g = gm_1m_2/d^2$, where g is known as the gravitational constant.

This formula can be used in turn to give answers to a host of problems. Newton used it to help explain why Kepler's laws worked out. A modern designer of space ships or rockets would use it to help predict what will happen as the rocket flies farther and farther away from the earth. (*See also* Space Travel)

Whenever possible, physicists try to discover laws and prove them true by experiments in which the

variables involved can be controlled or measured accurately. For example, Faraday discovered the laws of electrolysis by measuring how much material was transported by known amounts of electric current in an electrolytic cell. Millikan determined the fundamental unit of electricity, the charge carried by one electron, by making thousands of measurements upon microscopic droplets of oil which were kept dancing in a vacuum between oppositely charged metal plates.

Often when physicists cannot make a direct experiment, they can solve problems indirectly. An example is the way physicists learned the chemical composition of the sun and the stars. Direct tests were impossible, because no human being could hope to approach close enough to the sun or a star to get a sample for chemical analysis. But about a century ago, a way was found around this difficulty.

GALILEO SHOWS MILTON HIS TELESCOPE

One of the earliest inventions in modern science was that of the telescope. When Galileo heard of it, he made an improved type and used it for astronomical observations. In this picture he is showing his telescope to an English visitor, John Milton, who later became famous as a Puritan scholar and as one of the greatest of English poets.

For a long time, physicists had known that light from a glowing substance, such as the matter in the sun, could be separated into bands of colored lights, called the *spectrum*. In the case of sunlight, this spectrum was crossed by many fine dark lines, called *Fraunhofer lines*. In 1859, Kirchhoff and Bunsen found that these dark lines could be matched exactly by bright ones produced by setting chemical elements to glowing in a laboratory. Thus the lines told exactly what chemical elements were in the sun. This made it possible to learn the chemical composition of stars by using a spectroscope attached to a telescope. Modern refinements also indicate the speed and direction of the stars' motion and their temperatures (*see* Astronomy; Spectrum).

How Knowledge of Physics Developed

At first thought, it might seem that physicists, in trying to explain the physical universe with relatively few natural laws to work with, would begin by discovering the fundamental interactions between matter and energy. This is exactly what the ancient Greek philosophers tried to do, more than two thousand years ago; but they were not very successful because they tried to learn too much too fast.

They tried to uncover the deepest secrets of the physical universe before they knew the simple facts which would have given them a backlog of information. For example, they knew nothing about the workings of electricity and magnetism. Their understandings of light and heat were scanty and largely wrong. Their ideas concerning the chemical nature of matter were inaccurate. Furthermore, they failed to test their ideas by experiments. Naturally, they could not even begin to guess at the nature of matter or of energy.

Men began making some progress a thousand years later, in Galileo's time, by attacking the problem the other way around. These men were content to attack specific problems that could be tested with exact methods and to let more general theories wait until the theories could be put together by using knowledge that had been tested and proved.

During the two centuries after Galileo's time, real progress was made. By the early 1800's, physicists had won considerable basic knowledge about the interactions of specific forms of energy, such as heat or gravitational attraction, and matter. Even then, however, each type of interaction had to be studied separately. Nobody could begin to gather the interactions together into a general theory of the physical universe until more than a century had passed.

A survey of physics can be made best by proceeding as the physicists did, considering first the separate, specific types of interaction between matter and energy. The most basic topic in the study of physics is *mechanics*, because it establishes fundamental measurements which enter into all interactions. Different units are needed for measuring various forms of energy such as light and electricity. However, physicists keep these units consistent with those used in mechanics, thus helping to hold all the branches of physics together as one body of knowledge.

Ancient Beginnings of Mechanics

Primitive man maintained his place in the world not by brute force but by learning how to use stone tools, bows and arrows, and other mechanical devices. No one knows just when men began to use sticks as levers or exactly how and when they developed the wheel, but it is known that the physics of simple machines and the science of measurement developed

early. About 2600 B.C. the Great Pyramid of Egypt was built with sides which differ by less than one inch in their lengths of 762 feet and with corners which are right angles within 12 seconds of arc. This achievement required excellent measuring equipment and skill in using it. Practical knowledge and skill were needed also to quarry the tremendous masses of stone, to transport them, and to assemble them into finished structures (*see* Pyramids).

About 330 B.C. Aristotle wrote his celebrated book 'Physics', which was the dominant authority for many centuries. Although this book contained many principles whose validity has been well established, it also contained some assertions which are wrong. Perhaps the most famous is the statement that bodies of greater weight fall through equal distances in less time than lighter bodies. It was almost 2,000 years later before this principle was proved to be incorrect by the experiments of Galileo.

Archimedes of Syracuse was another great scientist who lived before Christ. One of his most celebrated discoveries was the principle of buoyancy, which enabled him to learn whether or not Hiero's crown was made of pure gold. Archimedes also made important contributions to knowledge of levers and pulleys, and he once boasted, "Give me a place to stand and to rest my lever on, and I can move the earth." (*See* Archimedes.)

Galileo Founds Modern Mechanics

Although a number of important discoveries in mechanics were made during the next 18 centuries, it was Galileo who opened the door to an entirely new world of physics. At the age of 19 he timed with his pulse the swings of a great chandelier in the cathedral at Pisa and found that the swing always took the same time, even though the size of the excursion became smaller and smaller. He then invented a simple pendulum for measuring time. This was a great improvement over the sand and water clocks then in use.

Galileo studied the motions of falling bodies and, in contradiction to Aristotle's claim, found that heavy bodies fall at exactly the same speeds as lighter ones when air friction is discounted. He also studied accelerated motion by rolling balls down inclined planes. His experiments laid the foundation for modern mechanics. (*See also* Mechanics.)

Earlier workers such as Roger Bacon had insisted upon careful observation and experiment as the way to win knowledge, rather than depending upon mere appearances. Nonetheless Galileo is considered the father of the experimental, or scientific, method because he devised the critical experiments which forced conviction even though the results contradicted earlier authorities (*see* Galileo).

Newton's Monumental Contributions

In the year Galileo died (1642), there was born in England one of the greatest scientists of all time, Isaac Newton. His studies of falling bodies and of the solar system led to his celebrated law of universal gravitation (*see* Gravitation). Not only did he discover many of the basic laws of mechanics, including the fundamental laws of motion, but he also developed a special mathematics for treating problems in mechanics. Thus he became one of the discoverers of *calculus*. The other was Gottfried Leibnitz. (*See* Calculus; Mechanics; Newton.)

Newton provided firm bases for expressing natural laws as mathematical formulas. His method started with locating objects in space with measurements made to three axes at right angles to each other through a chosen point called the *origin*. Such measurements are called *Cartesian co-ordinates* after the man who devised them (*see* Geometry). Newton's next working principle was that objects remain motionless or in uniform motion (same speed in a straight line) unless something happens to produce a change. Newton called this "something" a *force*, and he provided methods for measuring mechanical forces and their effects.

Newtonian and Relativistic Mechanics

Scientific reasoning based upon these principles has come to be called "Newtonian mechanics," "the Newtonian view," and (in the 20th century) "classical physics." Newton's methods proved adequate for explaining all motions and mechanical effects known to science for two centuries after his time.

During the 18th century mechanics was developed into a well-integrated and mature science through the work of men such as Leonhard Euler, the Bernoullis, and Joseph Louis Lagrange. In the 19th century the theory of gyroscopes was developed, and the kinetic theory of heat was worked out in terms consistent with Newtonian mechanics (*see* Heat).

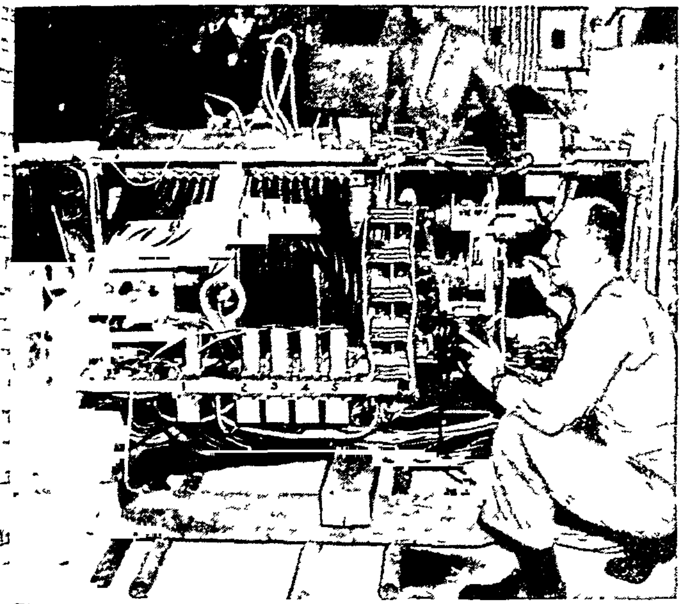
Late in the 19th century, however, A. A. Michelson and E. W. Morley made experiments with light and got results which contradicted all existing theory. After physicists had struggled for years with the problem, Albert Einstein in 1905 provided a solution with his first (or "special") theory of relativity. He said that certain "relativistic corrections" of Newton's mechanics would be needed in dealing with speeds approaching that of light. His views proved correct in every case in which they could be tested. Today relativistic corrections are made whenever needed (*see* Relativity). They, together with other 20th-century developments, have been particularly helpful in working out the modern theory of the atom.

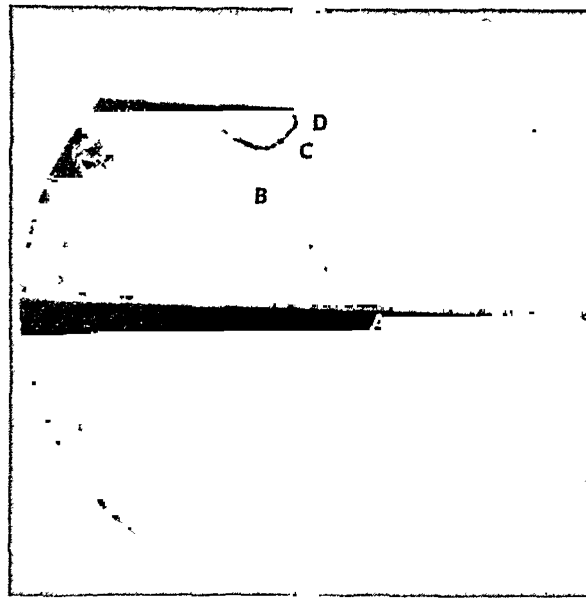
Old and New Concepts of Heat

Physicists now regard heat as being related somewhat to mechanical motion. The modern kinetic theory holds that heat as it exists in matter is simply "molecules in motion." This was not established, however, until after centuries of working with mistaken concepts.

The ancients thought that heat was an element. Empedocles proposed that the "roots of all things" are the four "elements"—fire (heat), air, water, and earth. Therefore heat could only be analyzed as something that flows into and out of substances. Even as brilliant a scientist as Lavoisier, toward the end of the 18th century, considered heat as something of this sort which he called *caloric*.

THIS POWERFUL CLOUD CHAMBER AIDS COSMIC RAY RESEARCH





This apparatus, carried to the upper atmosphere, is designed to obtain cloud chamber tracks of subatomic particles that are created by cosmic rays (left). The chamber is carried inside wiring which provides an electromagnetic field, and the wiring in turn is surrounded by cooling coils. At the right is an example of *pair production*, revealed by a cloud chamber. At A, a gamma ray or cosmic ray has struck a lead plate. Apparently the energy is converted into an electron (B) and a positron (C) which are driven out from the lead as a pair. Since the cloud chamber is in an electromagnetic field and the expelled particles have opposite charges, they follow opposite curved paths. At D, the positron has bounced after striking a metallic film.

Experiments, however, constantly disproved this view. Weighing matter when it was hot, then cold, showed no change that would correspond to a flow of caloric in or out of the substance. Eventually a group of physicists reasoned that motion was transformed into heat (as when a bullet strikes through a piece of wood), and they developed the view that heat was not an element or a substance. It was produced rather by the motion of the invisible particles which compose matter and which we now call molecules. Many different kinds of experiments consistently showed this to be true and thus established the *kinetic theory* that heat is energy associated with molecular movement. (*See* Heat.)

This theory proved satisfactory for the heat contained in matter. At the same time physicists developed a theory that *radiant heat* passing through empty space (infrared radiation) was a type of "wave in ether." The waves were emitted by a hot body such as the sun; and when they struck matter (as on the earth) they stimulated the molecules in the matter to greater motion. This "heated" the matter.

Planck's Quantum Theory of Heat

According to this theory, heat that was emitted and absorbed could be any amount between the "hottest" and "coldest" levels of the bodies concerned. In 1900, however, Max Planck forced a change in this view. He had experimented with a *black body radiator,* a hollow object which absorbed heat energy sent into it through a hole, then reradiated the energy somewhat as iron would. As iron is heated more and more, it first gets hot, then glows with dull red light, and finally becomes "white hot"—meaning that it is emitting every wave length of light in the spectrum as well as radiant heat and ultraviolet radiation.

The view that heat energy is infinitely divisible required a certain distribution of energy between the wave lengths of reradiated energy. Planck found an entirely different distribution. He explained this by saying that radiant heat energy is *not* infinitely divisible. Instead, it travels in particles and not in waves; and there is a certain "smallest particle" which cannot be divided. Planck called this "smallest particle" a *quantum.*

Since Planck's experiments were unquestionably accurate, physicists had to accept this *quantum theory*. Soon the same sort of "indivisible unit" was found in light and in electricity; and today the quantum theory ranks with relativity as one of the cornerstones of modern physics. The only change from Planck's view is a later theory which says that quanta travel *in association with waves,* as explained later in this article (*see* Energy; Matter).

Acoustics, the Science of Sound

Much of what we know about the world comes to us through sight and hearing. The ancients naturally were interested in the light by which we see and the sounds which we hear. Of the two, sound proved much easier to understand, and facts about sound began developing at an early date.

The physics of sound is called *acoustics.* Man's love of music led him to build musical instruments from which he learned that all bodies which produced sounds were *vibrating,* or moving to-and-fro. Fast vibrations produced sound of high pitch and the slower the vibrations the lower the pitch. By the 6th century B.C. the laws of stringed instruments were investigated by Pythagoras, the "founder of acoustics." During Augustus Caesar's reign, Vitruvius wrote that sound is produced in the form of con-

VOLTA SHOWS ELECTRIC CURRENT TO NAPOLEON

After Volta discovered the electric battery, he visited Paris and other places to give demonstrations. Magnetic and electrolytic effects of steady current were as yet unknown; but Volta showed the presence of current by drawing a spark whenever he touched the battery terminals with an electrophorus.

centric waves like those made by a stone when it is thrown into still water. The sound waves consist of an ever-widening sphere of *condensations*, regions where the air molecules are crowded together, and separated by *rarefactions*, regions where the molecules are farther apart than usual.

Early in the 17th century the French priest Mersenne measured the speed with which sound travels. He found that in one second a sound goes about 1,100 feet. Very loud sounds, such as those from a cannon, travel somewhat faster. A few years later Newton developed a theory which predicted the speed of sound from the elastic properties of the air, according to Newtonian mechanical principles. (*See* Sound.)

The Problem of Explaining Light

The ancients were familiar with many optical phenomena such as shadows, rainbows, and the use of fire in lamps to produce light. They knew about reflection and that light was bent when it went from water to air (refraction). Lenses were made and used.

In 1608 Jan Lippershey built what was probably the first telescope. Shortly after, Galileo made a telescope with which he discovered the satellites of Jupiter, the crescent phases of Venus, sunspots, and the rotation of the sun. About this same time the first microscope came into use. With these new optical instruments it was possible to make great strides in astronomy and in the biological sciences.

About the middle of the 17th century two great physicists were performing experiments with light. Both came to very different conclusions. One was Newton. He separated white light into its colors, built a reflecting telescope, and observed colored rings (called Newton's rings) when a lens was squeezed against a flat piece of glass. Newton accepted the theory that light rays were streams of little particles. He explained that light bends as it goes from air to water because the little particles were attracted toward and pulled downward into the water, *gaining speed* as they entered the water.

At the same time Christian Huygens developed a wave theory of light with which he explained many phenomena such as why everything looks double when viewed through a crystal of calcite. According to Huygens' wave theory, light bends when it goes from air to water because the waves move *more slowly* in water than in air.

For more than 100 years the argument raged between supporters of the particle and wave theories. At length certain experiments gave support to the wave theory. When two beams of light overlap at a point, they may add to produce brightness or they may cancel one another and produce darkness. This phenomenon is called *interference*. Shortly after 1800, Thomas Young and later Augustin Fresnel performed many experiments which demonstrated the interference of light. Their results supported the wave theory. About 1850 D. F. Arago, J. B. L. Foucault, and A. H. L. Fizeau showed that light travels faster in air than in water. This was a great triumph for the wave theory, and it convinced physicists that it was the only true theory.

For 100 years the wave theory reigned supreme. Then in 1900 it became evident that sometimes light showed particle properties, although they were very different from the particle properties Newton had described. Now it is known that light sometimes behaves like a wave and sometimes like a particle. Modern physicists must answer the question, "Is light a wave motion or a particle phenomenon?" with the answer, "It is both."

Reading the Riddles of Electricity

Even before the particle properties of light were understood, physicists had shown that light was the result of electrical activity in atoms and that a knowledge of electricity was necessary to understand the behavior and properties of light.

Lightning, electric eels, magnetic stones, and the attraction for bits of chaff exerted by rubbed amber were known long before the Christian Era. Nevertheless, knowledge of electricity developed much more slowly than any other branch of classical physics.

In the 17th and 18th centuries, however, this previously neglected subject received much attention. It was shown that many materials could be "electrified" by rubbing them with silk or fur. Such experiments seemed to indicate that two kinds of electricity (called *charges*) might exist. Each seemed to repel others of the same kind and attract their opposites. This could happen only if there were two kinds of charge or if one kind existed "in excess and defi-

ciency"—that is, in positive (+) and negative (-) amounts. An excess would tend to flow toward ("be attracted by") a deficiency. This view became the favored one.

During this period, experimenters were hampered by the fact that whenever a path was formed between opposite charges, they seemed to unite almost instantly. All studies would have to be made during such instants. Then in 1800 Alessandro Volta announced the discovery of an electric battery which would produce a steady flow of direct current. This stimulated research in electricity to an unprecedented degree. Experimenters such as Humphry Davy, H. C. Oersted, and Michael Faraday used this new source of electricity to discover such facts as the ability of a current to break up dissolved substances (electrolysis) and the ability shown by an electric current and by magnetism, each to generate the other. When this power was harnessed in large-scale generators and motors, the electric age was born. (For details of these and other discoveries, *see* Electricity.)

The Electromagnetic Spectrum and Radio

Electric charges as well as current and magnetism exert influence across space. In 1873 James Clerk Maxwell published his theory that electromagnetism moves across space at the speed of light in waves identical to those of light except for their wave lengths. In 1887 Heinrich Hertz detected such waves. Guglielmo Marconi used these discoveries in developing the radio (*see* Marconi; Maxwell; Radio).

Radiant heat and other radiations were found to conform to Maxwell's theory. Together they make up the *electromagnetic spectrum* (*see* Energy). This seemed to prove that all radiant energy moves in waves. However, another phase of Hertz's work (and work done by others) revived the particle theory.

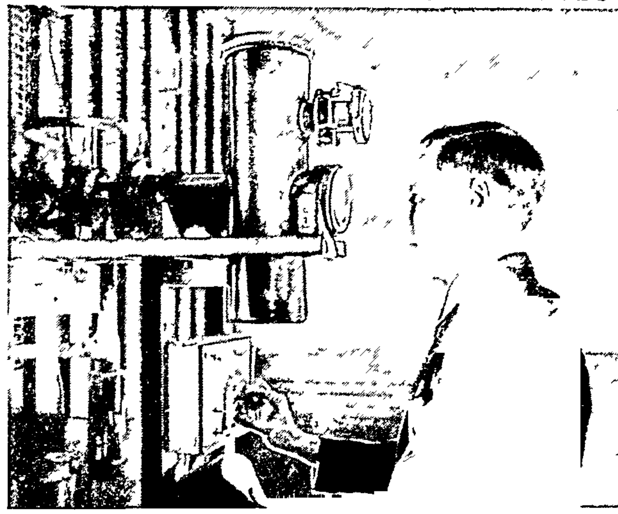
The Nature of Electricity and the Atom

During his experiments, Hertz had found that light falling upon metal would drive out a negative charge. (This phenomenon is called the *photoelectric effect.*) Further experiments suggested that the charge might consist of particles. Evidence of particles was also being found in electric discharges through a vacuum; and in 1896 Antoine Henry Becquerel discovered the natural radioactivity of uranium. Shortly after, Marie and Pierre Curie discovered radioactive polonium and radium (*see* Curie). Studies revealed that there were three kinds of radioactive rays, called *alpha, beta,* and *gamma.* Alpha rays were found to be positively charged particles; beta rays were negative particles; and gamma rays were electromagnetic pulses that carried more energy than the X rays discovered by Wilhelm Roentgen in 1895 (*see* Radiation; X rays).

Other experimenters proved that electrons exist and that they are one of the building blocks with which atoms are constructed. Beta rays were proved to be electrons. By 1900 it was clear that atoms are made of smaller electrified particles (*see* Atoms).

It also became clear that free electrons exert a negative charge; and electric current consists of electrons moving through a conductor. Thus electricity and atoms are intimately connected, and both are "particle" in nature.

DIFFRACTION SHOWS ELECTRON WAVES



The electron camera (top) and the photograph of a diffraction pattern (bottom) demonstrate an extremely important fact. Although electrons are unquestionably particles, they must travel in association with a wave pattern such as that of light. Otherwise, diffraction would be impossible.

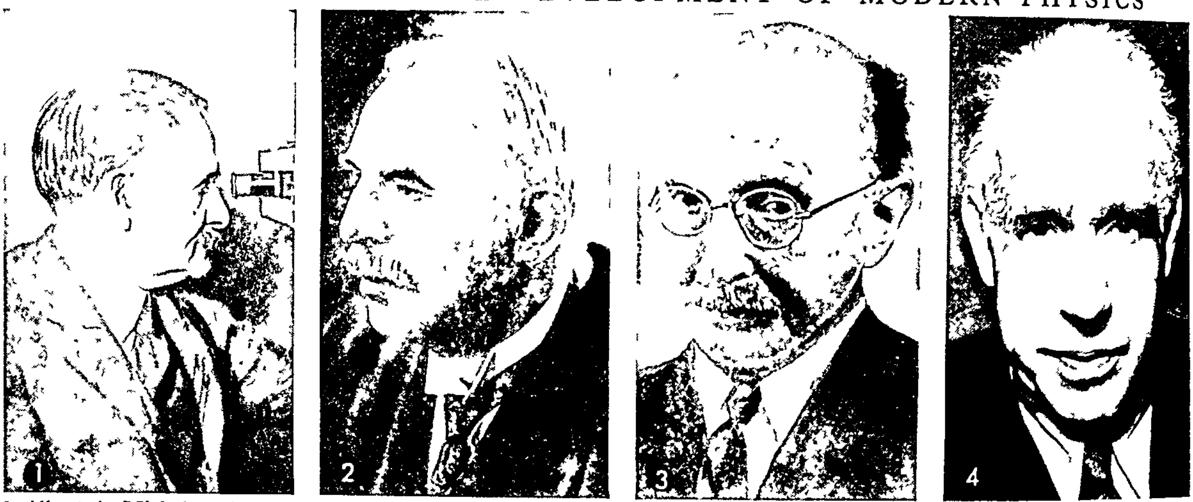
Physics in Our Century

Planck's quantum theory of heat strengthened the particle theory; and in 1905 Einstein explained the photoelectric effect with a theory that light consists of particles called *photons.* One photon striking metal could drive out one electron (negative charge). Photons were considered quantized, using Planck's value.

Starting in 1909 Robert A. Millikan measured the charge on one electron and in thousands of experiments found no smaller charge. Ernest Rutherford, in 1911, discovered that atoms have a very heavy positively charged core, or *nucleus,* which is surrounded by negative electrons. In 1913 Niels Bohr explained how the one electron of a hydrogen atom absorbs energy and emits the lines of the hydrogen spectrum, thereby connecting light with atomic structure. (Ultraviolet radiation and X rays could likewise be connected, under a later theory.) In 1924 Arthur H. Compton showed that reflection of X rays from a target could be explained by considering X rays as particles.

Thus the particle theory seemed to be sweeping the field. Yet the particle theory could not explain the diffraction of light; and in 1927 Clinton J. Davisson and Lester H. Germer found that beams of electrons could be diffracted by crystals. Thus it seemed that both the particle theory and the wave theory must be correct. The problem was to find how *both* could be true. By 1927 the mathematical physicists

FOUR LEADERS IN THE DEVELOPMENT OF MODERN PHYSICS



1. Albert A. Michelson helped to start a "revolution" with an experiment which raised doubts concerning 19th-century theories about light. 2. Ernest Rutherford worked out the nature of the atomic nucleus. 3. Max Planck proved that radiant heat energy travels as particles (quanta) instead of waves 4. Niels Bohr developed the first "workable model" of a hydrogen atom

Louis de Broglie, P. A. M. Dirac, Werner Heisenberg, and Erwin Schrödinger between them accomplished this with what is called the theory of *wave mechanics*. This held that all forms of radiant energy exist as quantized particles; but the particles travel through space and interact with matter *in association with a wave pattern* which arises and travels with them. How the pattern arises and why it directs the movement of the particles, the theory does not explain; it just asserts in mathematical terms that this happens. (*See* Energy; Matter.)

This theory by no means explains all the problems which confront physicists today; but it does draw together all previously won knowledge into a consistent theory. It ranks with relativity and the quantum theory as one of the cornerstones of modern physics.

Careers in Physics

As we learn more about how nature behaves, there is an increasing need for persons trained in physics. In the past the majority of openings for young physicists were in the teaching profession—elementary-school general science classes, high-school physics, and college and university physics programs. The more advanced the courses to be taught, the more extensive the training for the scientist had to be.

Although the number of physicists engaged in teaching has increased over the years, a much greater growth in vocational opportunity has come in industry and in government laboratories. Many of our major industries employ large numbers of physicists. They direct their efforts toward pure research, developing new products, maintaining quality standards, and promoting efficient production. Physicists in the research laboratories of our industries have helped to develop or improve X rays, radios, television, and the electron microscope—to name a few. Prominent among the types of corporations which hire a large number of physicists are those in the electrical, electronic, and communications fields. The major automobile and chemical corporations also have extensive laboratories in which there are many opportunities for physicists. In some industrial laboratories physicists work chiefly on problems which are important to that particular industry. Other industrial laboratories offer able physicists an opportunity to do the purest sort of research. Many notable discoveries have been made by physicists in industry, and the industrial scientist becomes more important year by year.

Government agencies employ large numbers of physicists. Opportunities in government work have expanded rapidly in recent years. The National Bureau of Standards houses the fundamental standards of weight and length. It provides standard time signals and maintains standards for measuring temperature, illumination, and electrical quantities. When thermometers or other kinds of meters are used to make measurements of great precision, they are usually sent to the Bureau to be compared with the basic national standards. In addition to maintaining and providing our national standards the Bureau is an important research laboratory.

The government offers employment to physicists in connection with many other organizations, such as the Agricultural Research Laboratories, the Bureau of Nutrition and Home Economics, the Geological Survey, the Bureau of Mines, and the Weather Bureau. Through the Civil Aeronautics Administration and the National Advisory Committee of Aeronautics the government employs physicists who are interested in problems in aviation. The Atomic Energy Commission supports a number of major laboratories which are well staffed with physicists doing research in the applications of atomic energy to the peace-time problems of physics, biology, medicine, and chemistry.

The Army, Navy, and Air Force maintain large laboratories concerned with the applications of physics to warfare. Physicists employed here may work on fascinating projects involving rockets, guided missiles, supersonic aircraft, and radar networks.

REFERENCE-OUTLINE FOR STUDY OF PHYSICS

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The COMPLEX MECHANISM *of the* HUMAN BODY

PHYSIOL'OGY. The body of the average man weighing 150 pounds contains the equivalent of 100 dozen eggs, enough iron to make 4 tenpenny nails, fat contents sufficient for 75 candles and a good-sized piece of soap, phosphate for 8,064 boxes of matches, enough hydrogen (in combination) to fill a balloon and carry him above the clouds, and, besides all this, 10 gallons of water, 6 teaspoonfuls of salt, and a bowl of sugar. This gives us some idea of what we may call the *chemistry* of the human body. Its structure and its way of working are equally wonderful.

If we are going to run an automobile or a motorcycle we want to know not only what the different parts are and of what they are made, but we must also learn how each part works, or "functions," and what its purpose or use is in operating the machine. It is the same when we study an animal or a plant. The study of its *anatomy* (*see* Anatomy) will tell us the way it is built and even its minute structure, but it is the study of its *physiology* that tells us how each part functions when the animal is alive. This is not quite so easily learned as the former. For when we attempt to separate the parts that we may examine and study them, we are likely to kill the animal or plant, and the very part which we wanted to examine stops working, so that we have defeated the end for which we strove.

For many centuries this was the great stumbling block to scientists and physicians. There is still much that is mysterious in human physiology, for even today there are many activities of our bodies of which we know very little. We are learning, however.

In the early days, "humors" and "spirits" were supposed to control certain functions; and anatomy, physiology, and medicine were a jumbled mass of facts and fancies. Then men of deep thought and earnest work began to make independent investigations. The microscope was invented, and they could actually *see* the blood flowing through the capillaries from the arteries to the veins, when the animal was alive, and other activities as well. Since then our knowledge has constantly deepened and broadened.

The Four Groups of Organs

As a result of experiment and study we have learned that, as regards its functions, every human or animal organ falls naturally into one of four great groups.

First, there are those organs whose function deals with *nutrition*—that is, with feeding the different tissues of the body and disposing of its waste products. The blood in the animal supplies food to the different parts of the body; the heart pumps the blood; the stomach and digestive system prepare the food so that it may be taken up by the blood; the liver, pancreas, etc., help in the work of digestion; the kidneys aid in throwing off waste products; the lungs take from the air the oxygen which is needed by every living cell of the body and throw off the poisonous carbon dioxide which is made in the various chemical changes that

OUR INTERNAL MACHINERY

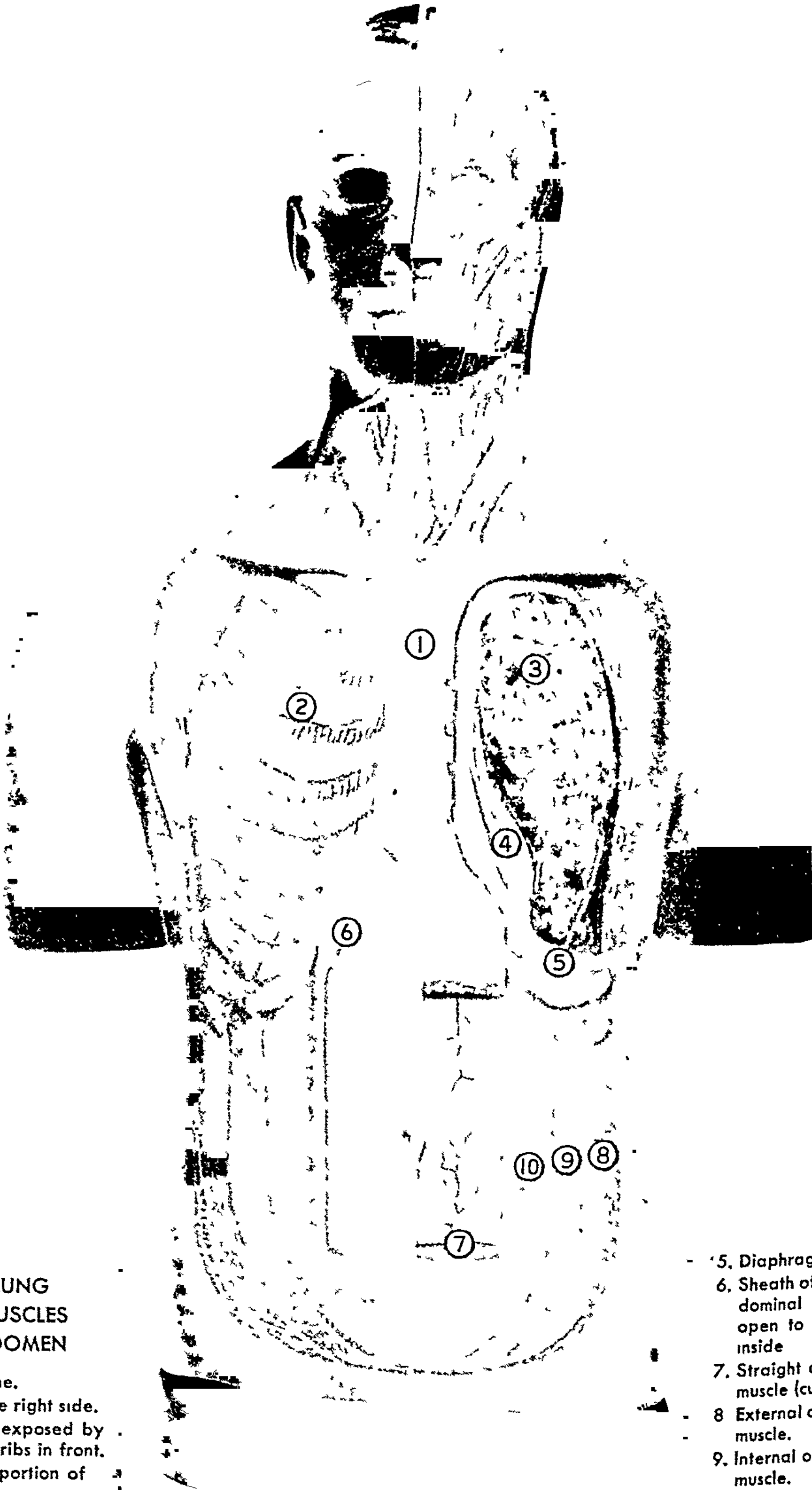
A

OUTER MUSCLES

1 The skin.
2 Layer of fat under the skin
3. Muscles of the face.
4. Neck muscle (sternomastoid).
5 Clavicle (collarbone).
6 Large pectoral muscle.
7 Straight abdominal muscle in its sheath
8. External oblique muscle of the abdomen

This series of photographs was made from the full-size, lifelike models used for instruction at the Museum of Hygiene and Medicine of the Mayo Foundation, Rochester, Minn (Copyright, The Mayo Clinic)

This model shows important outer muscles of the face, neck, chest, and abdomen. The sternomastoid neck muscle aids in movements of the head. The large, fan-shaped chest muscle gives strength to the arm and shoulder. The long, flat abdominal muscle compresses the abdomen and helps bend the body.

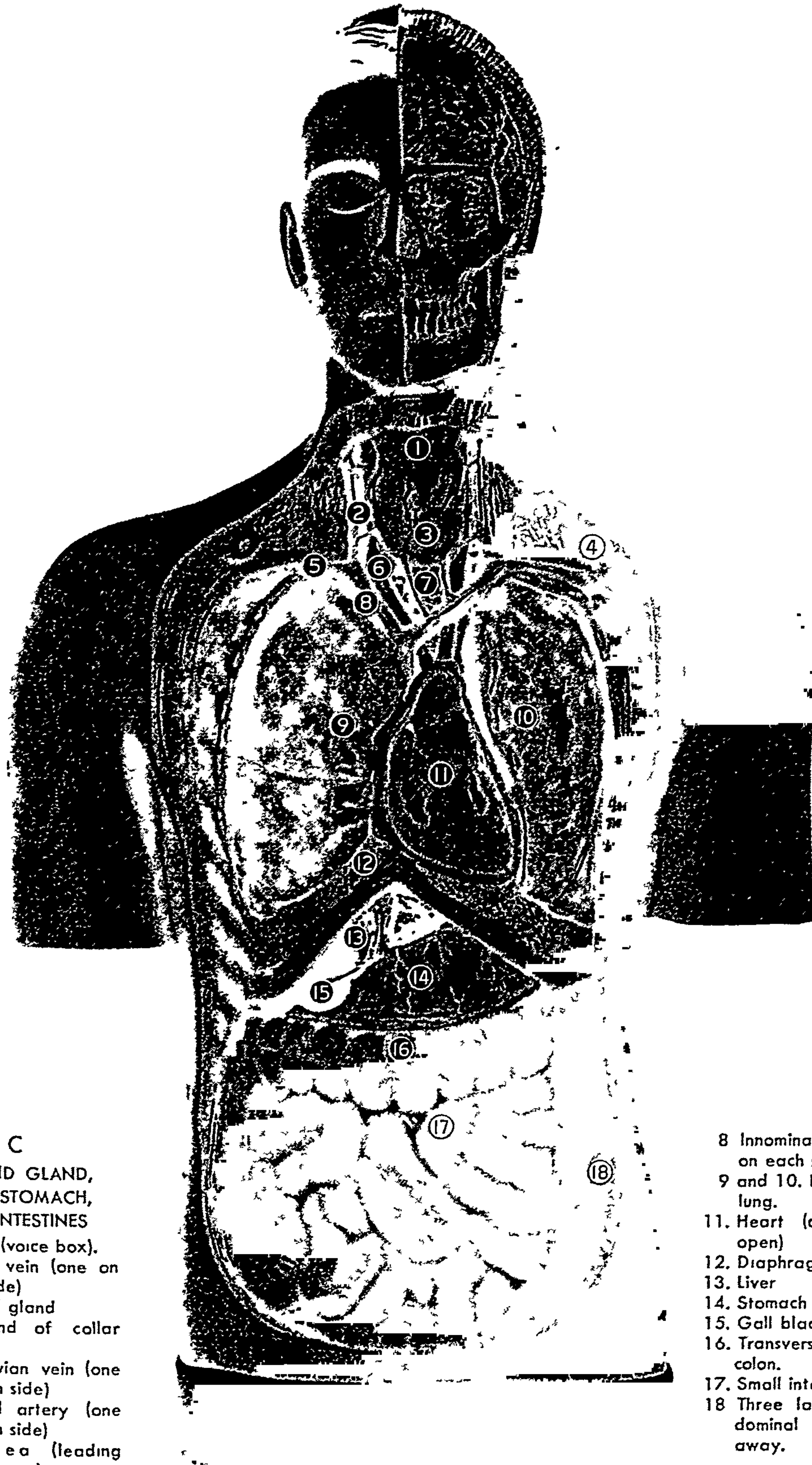


B

LEFT LUNG AND MUSCLES OF ABDOMEN

1. Breastbone.
2. Ribs of the right side.
3. Left lung exposed by removing ribs in front.
4. Exposed portion of the heart.
5. Diaphragm.
6. Sheath of straight abdominal muscle cut open to show muscle inside
7. Straight abdominal muscle (cut away)
8. External oblique muscle.
9. Internal oblique muscle.
10. Transverse muscle

In this model most of the outer muscles and the ribs on the left side have been cut away to show the left lung and the lower end of the heart, part of the diaphragm, and one of the pair of long abdominal muscles in section.

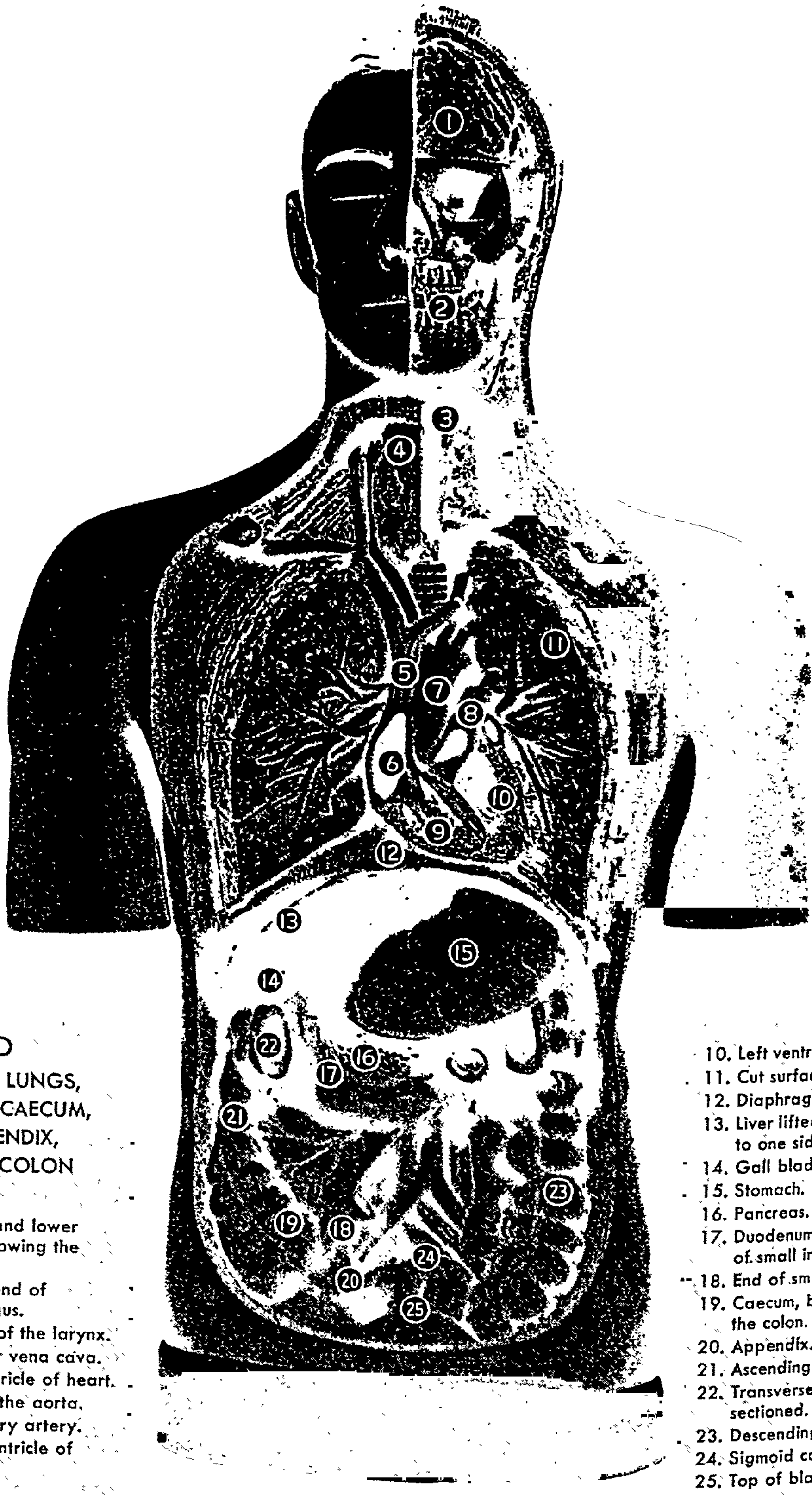


C

THYROID GLAND, LIVER, STOMACH, AND INTESTINES

1. Larynx (voice box).
2. Jugular vein (one on each side)
3 Thyroid gland
4. Cut end of collar bone
5. Subclavian vein (one on each side)
6 Carotid artery (one on each side)
7. Trachea (leading from larynx)
8 Innominate vein (one on each side)
9 and 10. Right and left lung.
11. Heart (covering cut open)
12. Diaphragm
13. Liver
14. Stomach
15. Gall bladder.
16. Transverse portion of colon.
17. Small intestine
18 Three layers of abdominal muscles cut away.

In this model most of the muscles of the neck and breast, the ribs, breastbone, and the abdominal muscles have been cut away to bring into view the larynx (voice box) and the trachea (windpipe), the thyroid gland, the jugular veins, and the carotid arteries, the heart (with its covering cut open), the lungs, and the diaphragm. Below the diaphragm appear the edge of the liver and the end of the gall bladder, part of the stomach, and the intestines.

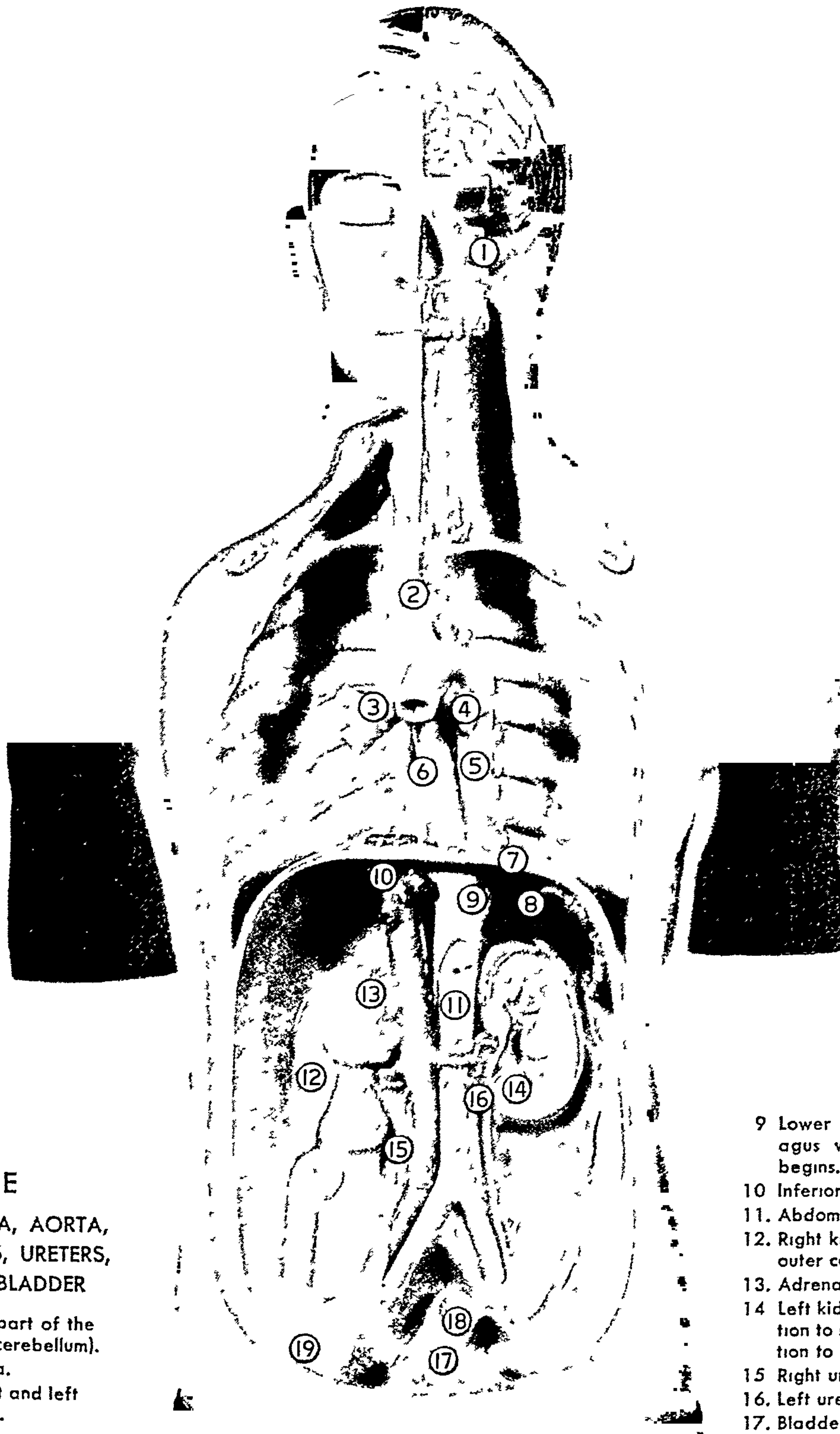


D

BRAIN, LUNGS, HEART, CAECUM, APPENDIX, AND COLON

1. Brain.
2. Upper and lower teeth showing the roots.
3. Upper end of esophagus.
4. Section of the larynx.
5. Superior vena cava.
6. Right auricle of heart.
7. Arch of the aorta.
8. Pulmonary artery.
9. Right ventricle of heart.
10. Left ventricle of heart.
11. Cut surface of lung.
12. Diaphragm.
13. Liver lifted and pulled to one side.
14. Gall bladder.
15. Stomach.
16. Pancreas.
17. Duodenum, beginning of small intestine.
18. End of small intestine.
19. Caecum, beginning of the colon.
20. Appendix.
21. Ascending colon.
22. Transverse colon sectioned.
23. Descending colon.
24. Sigmoid colon.
25. Top of bladder.

In this model a still deeper cut has been made to show the brain within the skull. Note the numerous branches of the windpipe in the lung and the various chambers of the heart. Below the diaphragm the liver has been lifted up to show the gall bladder, pancreas, and duodenum. The transverse colon and the small intestine have been removed to show the remainder of the colon and the bladder.



E

TRACHEA, AORTA, KIDNEYS, URETERS, AND BLADDER

1. Lower part of the brain (cerebellum).
2 Trachea.
3, 4 Right and left bronchi.
5. Aorta.
6 Esophagus.
7. Diaphragm.
8. Spleen.
9 Lower end of esophagus where stomach begins.
10 Inferior vena cava
11. Abdominal aorta
12. Right kidney with its outer covering.
13. Adrenal gland
14 Left kidney (cut section to show its relation to ureter)
15 Right ureter.
16. Left ureter.
17. Bladder.
18. Beginning of rectum
19. Lining of abdominal cavity (peritoneum).

In this model the lungs and the heart have been removed from the chest leaving the aorta, trachea, and esophagus attached to the backbone. The aorta and esophagus pass through the diaphragm. Below the diaphragm are seen the spleen, the kidneys, and the ureters from the kidneys leading to the bladder. The left kidney has been cut to show the inside.

take place throughout the system; the skin is also active in throwing off waste products. So each of these organs deals with nutrition and the nourishment of our bodies.

In the second group we place those organs whose work deals with *relation*—that is, whose function is to bring us information of the outside world about us (the eye, ear, nose, organs of taste and touch) and tell us our relationship to it. In this group we may place the muscles, which control our movements and hence our relation to people and things; and also the bones, which support and protect our bodies and are used as tools and levers by the muscles. The business of each of these parts of our bodies concerns our relation to the world of things about us or the interrelation of the parts of the body.

Organs of Intelligence

The third group contains the organs of *intelligence*, which include the brain and nerves. These receive sensations, store up impressions as memories, make decisions and plans, and transmit suggestions and orders to other parts of the body. The quickness and clearness with which this group functions is considerably affected by the general health of the first and second groups. The old Roman adage, "a sound mind in a sound body," was founded on physiological fact. The fourth and last group contains those organs whose work it is to reproduce the species. These are known as the organs of *reproduction*.

Nothing appears simpler than chewing and swallowing a mouthful of food; yet what a wonderful lesson in physiology is presented by this commonplace action! There is the tongue, which tastes the food, manipulates it in the mouth, and forces it back into the throat; the teeth, which crush and grind the food; the saliva, which softens it, eases its passage down the throat, and instigates the early stages of digestion (*see* Teeth; Tongue). The very sight or smell of tempting food stimulates the three sets of salivary glands—the parotids in the cheek, just beneath and in front of each ear (one who has had the mumps can locate them easily, for mumps is a swelling of the parotid glands); the submaxillary, under the angles of the jaw; and the sublingual, beneath the tongue.

The throat chamber, or *pharynx*, at the rear of the mouth is more than a mere vestibule into the gullet. Six passages lead out of it: two go upwards to the nose cavity; two, the tiny Eustachian tubes, lead to the ears; one, the glottis, is the slitlike opening to the windpipe; and one leads to the gullet or esophagus.

The Food Starts Its Journey

At the rear of the palate or roof of the mouth, hangs a small projection, the *uvula*, and over the glottis is a lid called the *epiglottis*. During the act of swallowing, the uvula moves backward to block the way to the nose, and the epiglottis closes the opening to the windpipe. At the same time, the muscles that surround the throat cavity quickly close in and force the food down.

The food is now in the *esophagus*, a straight tube which traverses the length of the chest cavity and passes through the diaphragm as it nears the stomach. Like the mouth and all parts of the alimentary canal, the esophagus is lined with mucous membrane, a soft thin covering which secretes mucus, and so furnishes a moist surface for the passage of food. Muscular rings in the wall of the esophagus contract and force the food slowly toward the stomach.

The Chest and Abdomen

The body cavity itself, technically called the *coelom*, should be considered at this point. It is divided by the diaphragm into two chambers, the thoracic or chest cavity, and the abdomen (*see* Diaphragm). The chest is a movable rigid box supported by the ribs and inclosing the heart and lungs (*see* Lungs; Respiration). The abdomen contains the stomach, intestines, liver, and all other internal organs. Attached to the surface of the chest walls, and enfolding the lungs, is a serous membrane called the *pleura*. Similarly, the abdominal cavity is lined with another membrane, the *peritoneum*, which also incloses the abdominal viscera. These membranes help support the organs and secrete a liquid resembling serum which provides a slippery surface. Hence, the organs can glide against one another and against the body walls without friction. It is these serous membranes that become inflamed in cases of pleurisy and peritonitis.

The esophagus communicates with the larger end of the pear-shaped stomach, and at the stomach's narrowed end, or *pylorus*, the small intestine begins. What happens to the food inside the stomach is itself a long and complex story described elsewhere (*see* Digestion; Stomach). The pylorus, a "gatekeeper" according to its Greek meaning, opens at the proper time and allows the food in the stomach to pass on into the small intestine.

This portion of the alimentary canal is a much-coiled tube to allow great space for soaking up or absorbing digested food. Absorption is one of the principal functions of the small intestine, and its adaptations for absorption are its most wonderful features. The lining of the small intestine is elevated into crescent-shaped ridges, which, like little dams, delay the onward flow of food, and increase the absorbing surface. In addition, these ridges of mucous membrane are covered with tiny velvet-like projections, called *villi*, so named from the Latin word meaning "shaggy hair."

Function of the Lacteals

Through the center of each villus passes one or more fine white threads, the *lacteals*, so called because of the milklike appearance of their contents. Their principal function is the absorption of fat. The lacteals are part of the lymphatic system, a system for draining lymph back into the blood stream. *Lymph*, a clear watery liquid, is simply blood plasma which has soaked out through the capillaries to nourish the cells of the body (*see* Blood). When lymph is charged with fat droplets, as happens in the lacteals, it is called *chyle*.

The fat absorbed by the lacteals is conveyed by lymphatic vessels to the large thoracic duct which runs upward along the spine. This duct empties into

veins at the root of the neck. Here the fat meets with venous blood from the head, largely carried downward by the jugular vein, and so passes onward to the heart. Other liquefied food substances, absorbed by the numerous blood vessels which line the villi, enter the blood stream directly. Before reaching the heart they pass through the liver, where the sugar is removed and stored in reserve form (glycogen) for the future needs of the body (*see* Liver).

Some of the fat is also stored away for future use as adipose tissue. This tissue forms a layer underneath the skin to keep the body warm and give it a rounded appearance, and, when oxidized, furnishes heat and power (*see* Biochemistry). It also acts as a cushion for many organs, such as the heart or kidneys.

The large intestine begins as a saclike pouch called the *caecum*, or "blind sac," then, as the colon, takes a somewhat rectangular course, up, across, and down the abdominal cavity. Then it passes to the exterior by a short straight tube, the rectum, by which undigestible and waste substances pass out from the body.

These processes are all co-ordinated by a complex system of controls. In addition to the central nervous system, with brain, spinal cord, and nerves going out to all parts of the body (*see* Brain; Nerves), we find in man and other vertebrates two knotted nerve cords strung along the outside of the spinal column, one on either side. The knots, or *ganglia*, are simply masses of nerve cells whose fibers form the connecting cord. This series of ganglia is the basis of the sympathetic nervous system, which presides over the processes of nutrition and growth.

One set of nerve fibers connects the sympathetic ganglia with the central nervous system, and another set goes out to the organs of digestion, respiration, circulation, and excretion. The sympathetic nerves unite with each other in fine networks or plexuses. One great network, for example, the *solar plexus*, situated at the pit of the stomach, sends branches to various blood vessels and organs within the abdomen. Another, the *cardiac plexus*, lies near the heart. A third, the *hypogastric plexus*, is in the lower part of the abdominal cavity. The chain of ganglia along the spine and the smaller ganglia in the plexuses serve as true nerve centers to regulate the action of organs over which we have no voluntary control, such as the peristaltic movements of the intestines. Since this nervous system is largely independent, it is often spoken of as the *autonomic* nervous system.

Chemical Regulation by Hormones

There are chemical as well as nervous regulators of the body. When, for instance, the food has passed through the stomach and enters the intestine, a new set of digestive juices is required from the pancreas. Whenever the intestine is touched by an acid (food coming from the stomach is acid), its cells secrete a hormone which is passed into the blood (*see* Hormones). This hormone, upon reaching the pancreas, rouses this tissue to active secretion. The secretion is passed down a duct into the intestine, and a new phase of digestion is begun.

Closely related to the study of physiology is the study of *hygiene*. *Anatomy* tells us how the organ is made; *physiology* tells us how the organ works or functions; and *hygiene* tells us how to care for it and keep it well (*see* Health).

So closely are these subjects related and so important is a knowledge of them to our well-being and happiness that governments have provided for them to be taught to children in the schools. For example, we know how our eyes are made and how they work, and we should also know how to protect and care for them so they will serve us as long as we live. Knowledge of these subjects is the key to health.

Physiology of Animals and Plants

The physiological processes of animals and plants resemble those of human beings in many ways. All forms of life use much the same chemical elements and transformations to support their fundamental life processes. They all require protein food and some type of energy food, such as carbohydrates, or materials from which they can make these foods. They all use water as a fundamental fluid. They also need mineral salts and some kinds of chemical regulators and aids, such as hormones and vitamins.

Every kind of animal or plant consists of one or more cells, and the living substance within each cell is some variety of protoplasm (*see* Cell; Protoplasm). Some cells form protective tissues, such as bark, shell, hair, or the outer layer of skin. Once formed, these cells need no more food and remain in place until worn out or destroyed. All cells which take active parts in living processes must be bathed in a fluid which brings food, oxygen, and other needed substances and takes away wastes through the walls of the cells.

In warm-blooded animals, physiological processes such as digestion and respiration are much the same as in man. The principal differences occur in the structure of various parts and in methods of reproduction. All but the most primitive mammals bear living young, but birds reproduce by laying and hatching eggs. In cold-blooded animals—those that take their body temperature from their surroundings—ways of getting oxygen also differ greatly. Insects draw in air through holes in the thorax and abdomen and distribute it through tubes to the body. Fish get oxygen from water by letting it flow over gills.

The physiology of plants is in principle the same as that of animals but is much simpler, as the activities of plants are simpler than those of animals and human beings. Nutrition and reproduction are the main branches of plant physiology. In the higher plants the root is an organ of nutrition for absorbing water, mineral salts, and organic matter which is soluble in water. The root, leaves, and stems are furnished with strands of tissues along which the water and food can travel. The leaves and, at times, the stem are organs for absorbing carbon dioxide and for giving off oxygen. They are also important in helping the plant to manufacture its food. Flowers and seeds are simply organs of repro-

duction to insure that the species does not die out (*see* Plant Life).

The many resemblances between all forms of plant and animal life help greatly in the study of human physiology. Many processes which would be difficult to study in a human body can be studied readily by experimental methods in animals or even simple plants, such as yeasts.

REFERENCE-OUTLINE FOR PHYSIOLOGY, HEALTH, AND MEDICINE

Note: For the general laws of life, see the Reference-Outline for **Biology**.

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  Note: Many common drugs improperly used are poisons. For a list of the principal poisons and their antidotes, see **Poisons** and **First Aid.**

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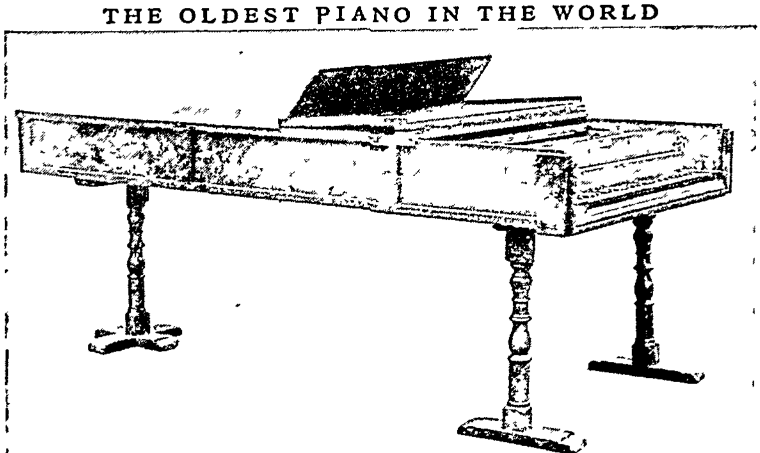
The STORY *of the* PIANO *and Its* ANCESTORS

PIANO. Near the close of the 17th century, a wealthy Italian prince of the Medici family hired Bartolommeo Cristofori to take charge of his collection of musical instruments. Cristofori was a harpsichord maker and so was especially interested in this and other instruments played by a keyboard.

These forerunners of the piano were of two general kinds: (1) the harpsichord type, in which the strings were plucked by quills or pieces of leather that rose and twanged the strings when the key was struck; (2) the clavichord, in which the strings were struck by brass wedges, or "tangents." Virginals, psalteries, and spinets were small instruments of the harpsichord family. Most of them had a small range, with only one string to a note, and were placed on a table for playing, though some harpsichords were large and shaped like a modern grand piano, with two, three, or four strings sounding in unison for a single note, thus increasing the volume of tone. The most elaborate harpsichords had double keyboards—one for producing soft tones and the other for loud tones—with stops and pedals for varying the effect. Some of them were upright, like an upright piano. Usually the spinet was small and each one of its notes had a single string plucked by a crow's quill or a piece of leather. A popular model is described as resembling a harp laid in a horizontal position, having its longest string only a foot in length, and with a compass of 31 notes.

THE OLDEST PIANO IN THE WORLD



This instrument, built by Cristofori in 1720, now considerably restored, may be seen at the Metropolitan Museum, New York City. It is one of the two oldest pianos in existence. The second was built by Cristofori in 1726. It is now in the Kraus Museum, in Florence, Italy.

Our knowledge and appreciation of these early instruments have recently been greatly increased by Arnold Dolmetsch, who devoted his life to collecting and making them and to demonstrating their qualities in concert work.

All these instruments lacked means of sustaining tones and were not easily controlled to bring out contrasts of loud and soft. Cristofori set himself to remedying these defects, and in 1709, 1720, and 1726

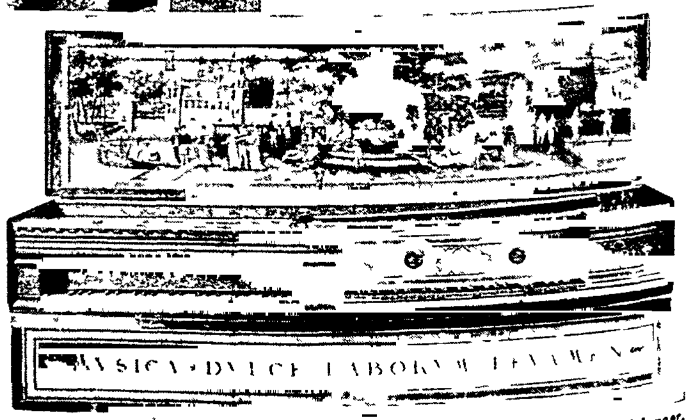
built instruments which gradually developed into the modern piano. The name piano is a shortened form for "pianoforte," given to the new instrument because it could readily be played either soft (Italian *piano*)

EARLY MEMBERS OF THE PIANO FAMILY

or loud (*forte*). The essential feature of the mechanism which accomplished this was the use of little leather hammers operated by a hinged lever—the same principle that is used in the action of the pianos of today.

There were, however, many defects in these early instruments, which kept them from becoming generally popular among musicians. Bach, Haydn, and Mozart continued to write for the harpsichord and the clavichord, though Mozart had a piano for his personal use; and it was not until many improvements had been made that the piano was fully accepted. Beethoven was the first great composer to write for the pianoforte.

Much of the great music of earlier masters, who wrote for the harpsichord or the clavichord, has had to be transcribed and adapted to the larger and more melodious instrument, as for example, the world renowned Czerny's pianoforte editions of the 'Preludes' and 'Fugues' of Johann Sebastian Bach.



The harpsichord of the elegant Dutch lady in the painting by J. M. Molenaer, now in the Ryks Museum, would sound odd and tinkly today, compared to a modern piano. But how fine is the painted scene on the inside of the lid, and also on that of Hans Ruckers' double virginal, below, made in 1581.

Making Pianos

The wood for a piano is chosen by a workman so expert that he can tell by its sound when it is struck whether it has the necessary qualities of resonance. Then it is weather-seasoned from three to ten years, and afterwards artificially dried for weeks.

The case consists of two sides or rims made up of many thin strips of wood bent to shape and glued together. They are supported and held in place by posts of heavy timber. These posts and the inner rim form the frame, or skeleton, of the instrument over which a thin, highly polished veneer of wood is laid. To this frame, at its front end, is attached the "wrest-plank" or pin-block, into which the tuning-pins are driven.

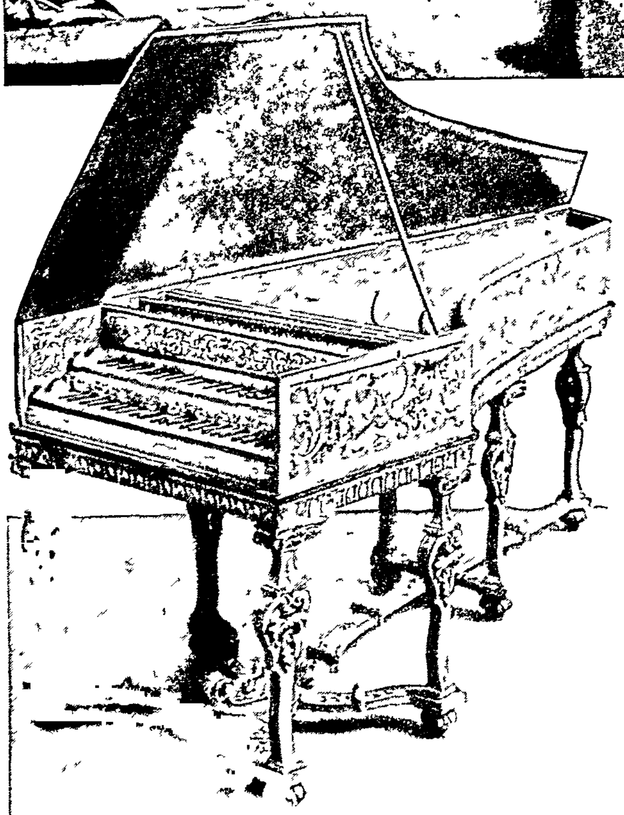
Over the framework as a whole is laid the convex or arched sounding-board, which is securely fastened at its edge to the inner rim. Over the sounding-board in turn is placed a metal plate to hold the strings, which are drawn across the plate from the tuning-pins at its front end to hitch-pins at its rear. The positions of these pins are carefully determined so that string tension may be nicely proportioned throughout. The action is then adjusted in such a manner that a felt hammer, upon being brought into play by the depression of its key, strikes a string or a group of strings in unison, and thus makes it vibrate.

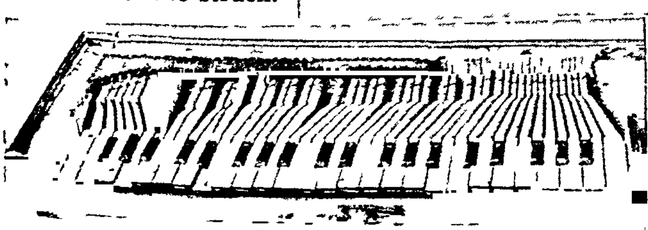
The strings, in being drawn from the front to the rear end of the plate, pass over a bridge, which is

glued to the sounding-board. Determining the proper height of the bridge is a delicate matter. If the bridge is too high, the downward pressure of the strings overbalances the upward pressure exerted by the arched board; if too low, opposite results follow. As the strings are set vibrating by the hammer blows, the vibratory motion is communicated through the bridge to the sounding-board, and thereby amplified and reinforced.

The best way to understand the action is to take out the front board of an upright piano and look inside. Press down a key and you will see how its rear end rises and lifts the "jack," which throws the hammer against the strings while raising the damper from them. You will see, too, how the dampers stop the strings from vibrating when you lift your hand from the keyboard, and how you can keep them vibrating, when you have taken your hand from the keys, by keeping down the right (damper) pedal. The left (soft) pedal in upright pianos shifts the hammers, so that their stroke is shorter and lighter; in grand pianos, it shifts the keyboard, so that only two of the three strings for each note are struck.

THE YOUNG HANDEL PRACTISES ON THE CLAVICHORD





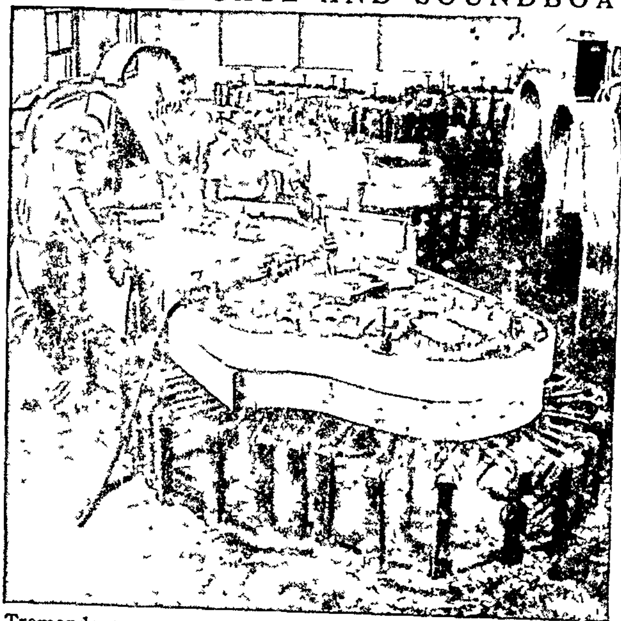
When George Frederick Handel was a little boy, his barber-surgeon father objected to his interest in music. So the lad slipped out of bed at night to practise on a clavichord, a soft-toned instrument, which a friend had put in the attic for him. The top picture, by Margaret Isabel Dicksee, shows the boy discovered. The elaborate harpsichord in the center was made by Jans Couchet about 1650. Below we see a German clavichord of the 17th century.

The middle or sustaining pedal, when pressed down after the keys are struck, holds the dampers away from those particular strings; whereas, the damper pedal holds the dampers away from all the strings.

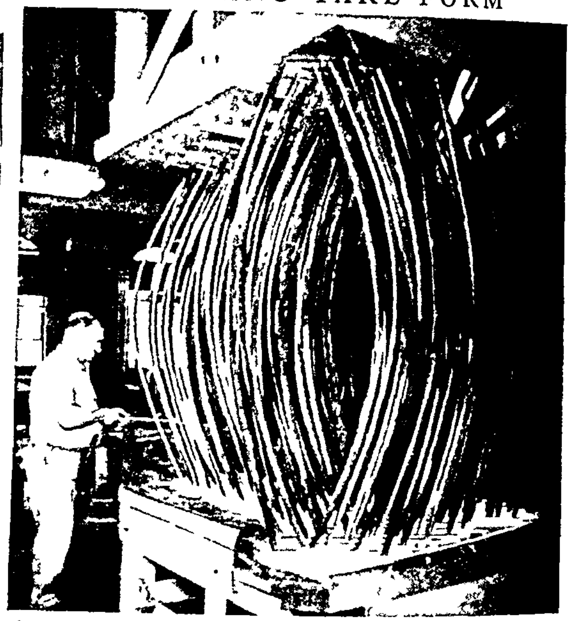
The tone of a piano depends to a considerable extent on the length and size of the strings, and on the resonance space. This fact accounts for the superiority of the grand piano over smaller instruments. The concert "grand" of today has three strings (tuned in unison) for most notes, but some of the bass notes have two strings, and the lowest notes have one. The frame is steel, the wires are stronger, and the heavier strings are wound with smaller wire. The standard piano keyboard has 88 notes, giving a compass of seven octaves and a minor third. Instruments designed to take up little space may have fewer.

The United States has contributed several noteworthy improvements to piano making. The upright piano was invented about 1800 by John Isaac Hawkins, an Englishman living in Philadelphia. Alphaeus Babcock, in the early 19th century, made a single casting of iron for the plate of his square piano; and Jonas Chickering, shortly after, applied this for the grand. Since 1885, this single metal plate casting with crossover-stringing, by

THE CASE AND SOUNDBOARD OF A PIANO TAKE FORM



Tremendous pressure must be exerted to form the heavy wood of which a piano case is constructed. The screw clamps here are permanently hinged to the molding form.



An unusual but very old method is used for clamping ribs to the soundboard while the glue is setting. Springy "go-bars" are wedged between the ribs and a heavy board overhead

which the lower strings cross the others diagonally, has been generally adopted. The total tension on the plate is more than 30 tons.

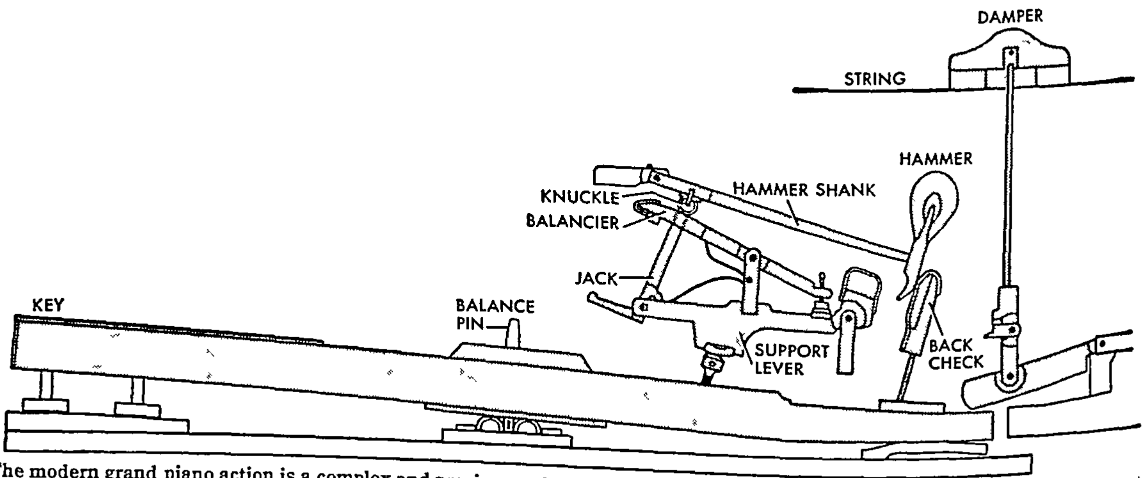
American inventiveness also produced the player piano. A United States patent for a mechanical piano was taken out in 1860 and most later developments were of American origin. The player piano was extremely popular, both in America and in Europe, from about 1900 to the mid-1920's, when radio replaced it in popularity. Music was recorded on paper rolls by means of punched holes. As the roll passed over a perforated bar in the player mechanism, air pressure caused the hammers to strike the strings. The Virgil practicer clavier was another American invention. This was a silent keyboard with which a musician could practice while traveling or when music would be disturbing to others.

The Jankó keyboard, invented in 1882 by Paul Von Jankó, a Hungarian musician, consisted of six rows of keys in steplike succession. With it, all diatonic scales could be fingered alike, and the pianist could stretch a 13th as easily as an octave on the conventional keyboard. Emanuel Moór in 1921 invented a double-keyboard piano. The lower keyboard could be coupled to the upper, tuned an octave higher.

Piano Music and Pianists

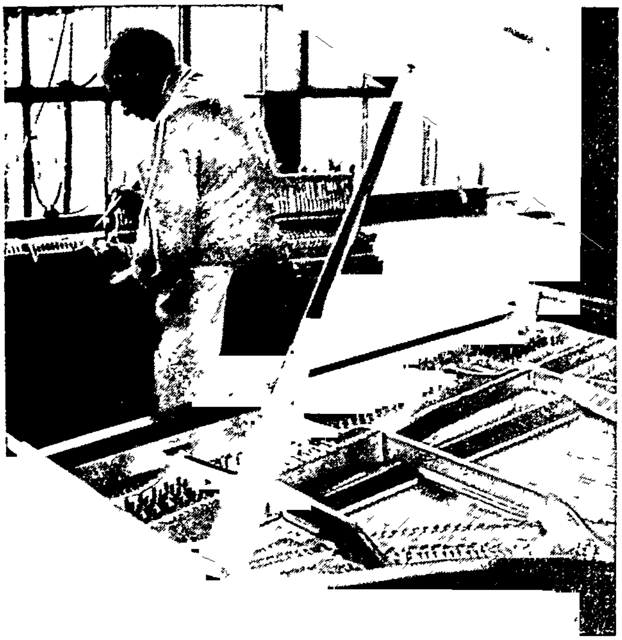
The piano occupies an important place in the development of music. Beginning with Beethoven, a vast

HOW THE ACTION OF A MODERN PIANO WORKS



The modern grand piano action is a complex and precise mechanism. As a key is struck, the damper rises from the string, and the support lever transmits force through the jack to the hammer, which is thrown upward to strike the string. Continued motion then tilts the jack forward in its slot in the balancier so that the hammer knuckle falls free of the jack on its return

THE VOICER AND HIS ART



Evenness of quality throughout its range characterizes the tone of a fine piano. The skilled voicer achieves this by pricking or filing the hammer felts to soften or harden them.

amount of music has been written for it alone and for combinations of the piano with stringed instruments or with the orchestra. The *sonata* is the most important piano solo form (*see* Music). There are also many shorter forms, however, such as the *romance, impromptu, fantasia, intermezzo,* and *étude.* The most important musical form for piano and orchestra is the *concerto.*

As the piano was slowly perfected, the music written for it increased both in amount and in complexity. It reached great heights in the music of Schumann, and more particularly in that of Chopin. As the tonal resources of the piano expanded during the 19th century, an impressive, if somewhat florid, style of piano playing developed. Liszt was the greatest master of this style, and he and many of his pupils achieved world-wide popularity. In the 20th century popular taste brought about a return to a less bombastic style in which the pianist gave more attention to phrasing and to pure tone than to virtuosity. Of the concert pianists of the first half of the century, Vladimir Horowitz and Artur Rubinstein were probably pre-eminent.

The piano is the favorite of all instruments for the home. On it can be played arrangements of symphonies, concertos, operas, and other musical forms. There is music for four hands on one piano (piano duets) and for two or more pianos. The piano can be used to accompany singing or another solo instrument, such as the violin. Practically all popular music is published in easy arrangements for the piano, and with a little knowledge of harmony, an amateur pianist can improvise to suit himself.

PIERCE *and His Troubled* ADMINISTRATION

PIERCE, FRANKLIN (1804–1869). The 14th president of the United States was the son of a Revolutionary War patriot of New Hampshire who was twice governor of his state and who taught the boy a strong love of country. Franklin Pierce was graduated from Bowdoin College in 1824, and after studying law for three years was admitted to the bar.

The prominent position which his father had occupied in the Democratic party in New Hampshire was a help to the son's political advancement. In 1829 he was elected to the state legislature and became speaker of that body. Four years later he was elected a representative in Congress. A supporter of Jackson's policies, he was sent to the Senate in 1837. When he entered the Senate he was the youngest member in it. Since such great men as Webster, Clay, and Calhoun were numbered among its members, Pierce was completely overshadowed and his voice was never heard in debate.

Before his term in the Senate had expired he resigned—with the determination, as he said, never again to appear in public life. This resolution was faithfully adhered to for years, although he was asked to become a candidate for governor of his state and was offered the place of attorney general in President Polk's Cabinet. He devoted himself to the practice of law and attained renown in his profession.

When the Mexican War broke out, Pierce followed the patriotic example which his father had set and enlisted as a private. He was soon given a commission as brigadier general and served under General Scott with bravery and credit. On the restoration of peace he resigned his commission and returned home to the practice of law. In 1850 he was president of a convention to revise the constitution of his state. In 1852 the Democrats, seeking party harmony, nominated Pierce as their candidate for president and William R. King of Alabama as vice-president. Pierce and King were elected by 254 electoral votes against 42 cast for Winfield Scott and William A. Graham, the Whig candidates, who carried only four states.

When Pierce was inaugurated, March 4, 1853, he was the youngest man who up to that time had taken the presidential oath. In his inaugural address he promised to uphold the Compromise of 1850 and that

PIERCE'S ADMINISTRATION
1853-1857

Gadsden Purchase from Mexico (1853).
Treaty with Japan negotiated by Perry (1854).
Ostend Manifesto issued (1854).
Know-Nothing Party at its height (1854–55).
Kansas-Nebraska Bill passed (1854).
Filibustering Expedition to Nicaragua (1855).
Border War in Kansas; John Brown and the Battle of Ossawatomie (1856).
Brooks's Assault on Sumner (1856).
Birth of Republican Party (1856).

FRANKLIN PIERCE

the repose which it had given the country should not be disturbed. Before his administration was over, however, he had given his support to the Kansas-Nebraska Bill, which reopened the slavery question and led directly to the Civil War (*see* Kansas-Nebraska Act).

President Pierce's change of position on the slavery question was only one example of the indecision that was evident during his whole administration. He would make up his mind on a question in the morning and change it in the afternoon. From being the most popular man in the country, by December 1853 he had come to be regarded as one of the most incompetent men ever in the presidency. His Cabinet, however, contained men of ability, such as William L. Marcy, secretary of state; Jefferson Davis, secretary of war; and Caleb Cushing, attorney general. It had the unique distinction of remaining unchanged throughout the administration.

In foreign affairs President Pierce's administration is notable for a treaty with Japan concluded in 1854 by Commodore Matthew C. Perry which opened Japanese ports to American vessels (*see* Japan). By the purchase from Mexico, in 1853, of a strip of territory in southern Arizona (the Gadsden Purchase), the southern boundary of the country was rounded out.

The South was eager to obtain more territory to be made into slave states. This was the purpose of William Walker's "filibustering" expedition against Nicaragua. President Pierce sympathized with his intention to set up a state there under American rule (1855). He also endorsed the Ostend Manifesto, signed by the United States ministers to France, Spain, and Great Britain, which declared that if Spain would not sell Cuba the United States would take it by force.

After completing his term, Pierce remained in retirement in Concord, N. H., until his death in 1869. Nathaniel Hawthorne, a friend and classmate at Bowdoin College, wrote his biography.

PIERRE (*pēr*), S. D. In 1880 a westward-building railroad reached the east bank of the Missouri River at the site of what is now Pierre, the capital of South Dakota. The site then was no more than a ferry landing for Fort Pierre, a bustling frontier town that had formed around a military fort established on the west bank as an Indian trading post in 1817. Pierre grew up about the railroad terminal, and in 1889, when South Dakota was admitted to the Union, it was made the state capital. The railroad was not extended across the river until 1907.

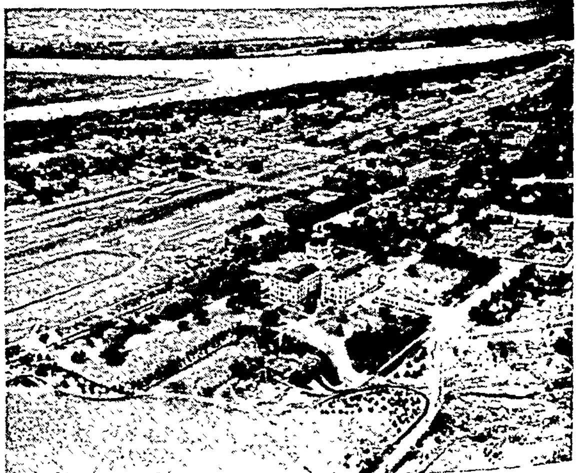
Pierre is situated near the geographical center of the state. To the west spread the grazing plains of the cattle country and to the east, fertile farmland. Pierre draws a considerable trade from both areas. Most of its workers, however, are employed in state and federal offices.

Dominating the wide-spreading city is the 165-foot dome of the Capitol, a sandstone and limestone building rising on a plateau. The Capitol was dedicated in 1910. Capitol Lake lies to its east and the Governor's Residence is on the opposite bank. Memorial Hall, built to honor the state's first World War veterans, rises opposite the Capitol. Its historical museum exhibits a lead plate found in 1913 on a hill overlooking Fort Pierre. The plate claims the area for France. It was buried in 1743 by the French expedition headed by La Vérendrye (*see* La Vérendrye in Fact-Index).

The whole of Pierre's river front has been made into parks. A short distance upriver is Farm Island State Park. Also nearby are the Pierre Indian School and the Rodeo and Polo Grounds, where a rodeo is held each year. In 1950, a few miles upstream, Army engineers began the immense Oahe Dam, a project of the Missouri River Basin development plan.

Pierre was incorporated in 1883. The city owns its electric plant and distribution facilities. Pierre has the commission form of government. (*See also* South Dakota.) Population (1950 census), 5,715.

SOUTH DAKOTA'S CAPITAL FROM THE AIR



The State Capitol rises from a butte near the center of Pierre, S. D. Lovely Capitol Lake (in left foreground) is fed by warm artesian water and attracts many migratory waterfowl.

PETS, MESSENGERS, *and* SYMBOLS *of Peace*

PIGEONS AND DOVES. Two billion pigeons in one flock is a big bird story but nevertheless a true one. Only about a century ago such a sight was common throughout North America. The wild passenger pigeon (or wood pigeon) was often seen in flocks 200 miles long, and it was found nesting in enormous numbers. Over a 150,000-acre tract of forest, 50 to 100 nests could be counted in one tree. The noise of these flocks could be heard for a distance of three miles, and thick branches often broke with the weight of the roosting birds.

Now, however, there is not a single living specimen of the passenger pigeon anywhere in the world. A prize of $1,000, offered for a pair of living birds of this species, remained unclaimed for years. The last of the captive passenger pigeons died—an old, old bird—in the zoological garden of Cincinnati in 1914.

The passenger pigeon was about 17 inches from tip to tail, a bluish gray color above and a reddish faun below. Because of this undercolor it was frequently called the red-breasted pigeon. Its wings and tail were long and pointed, giving it a neat, tailored appearance. It fed upon fruits, seeds and grain, and nuts.

The complete disappearance of the passenger pigeon is easily understood. It was exposed to reckless slaughter as the country became more thickly settled in the middle of the 19th century. Firearms could do in one generation what the bow and arrow had left undone for centuries. One shot from a modern shotgun, fired into a pigeon tree, would bring down enough pigeons to fill a game bag. Yet, not satisfied even with this wholesale killing, fowlers set large nets which sometimes took from 200 to 250 birds at one haul. The young just out of the nest, called *squabs*, were especially marketable, for they were tender and tasty. Expert pigeoners followed the flocks from roosting place to roosting place, tracing their whereabouts by telegraph and overtaking them by railroad.

The last recorded great nesting and slaughter in the United States occurred in Petoskey, Mich., in 1878. It is said that from this nesting place tons of birds were sent to the New York market and that it took 15 tons of ice to pack the squabs alone.

For 25 years after this raid, diminishing flocks were occasionally seen in various parts of the United States. They were relentlessly pursued until their extermination was complete.

The pigeon family has an ancient history. The names "pigeon" and "dove" are used almost interchangeably. The former comes from the French and Italian (from Latin *pipio*), while the name "dove" is akin to the Dutch *duif*. Commonly, but not always, the smaller members of the group are called "doves" and the larger ones "pigeons."

As city pigeons fly they watch for friends who feed them. At left, a pigeon guards and warms the eggs in its nest while its mate searches for food.

The famous dove of Noah's Ark belonged to this family. The bird was highly regarded by the early Hebrews, for their poor were permitted to sacrifice doves in place of costlier lambs.

The American turtle dove is much like the European species and is also known as the mourning dove. It is well known in most parts of the United States. Its soft gray plumage with a collar of changing amber lights, its sad little cooing call, and its quiet friendly habits endear it to all. (For illustration in color, *see* Birds.)

Many Species of Pigeons and Doves

More than 600 wild species of pigeons and doves are known throughout the world. They are most numerous in the Eastern Hemisphere. The birds vary greatly in their habits. Some build in trees, others on the ground; some nest in isolated pairs, others in colonies. In drinking they do not lift the head as most other birds do, but take the water in long drafts. The pairs are said to mate for life. Both parents take turns in incubating the eggs, which usually number two, and nourish the helpless young on partly digested food mixed with a secretion from the crop. This food is called "pigeon milk." About 12 species occur in North America.

Pigeons were tamed early, and domestic pigeons are now common throughout the world. Three thousand years before the birth of Christ, the Egyp-

tians raised pigeons for food, and probably used them also to carry messages.

The 150 or more named varieties of domestic pigeons, in spite of their great differences, have all been traced to the common ancestry of the wild rock-dove of Europe and North Africa. This fact was made known by the great scientist, Darwin, who, in developing his theory of "natural selection," found the pigeon one of his most plastic subjects for experimentation. He discovered that triple crosses between distinct varieties, of no matter what color, were very likely to produce, in the third generation, a color pattern precisely like that of the wild rock-dove, which wears a plumage of grayish-blue color with white on the lower back and two black bars on the wings.

WHY THIS PIGEON LOOKS SO PROUD

The Maltese or "Hen Pigeon" is a very proud and showy bird. These birds always attract much attention at pigeon shows because of their peculiar carriage.

Domestic pigeons are divided into four principal groups. The pouters are a very distinct race, having an esophagus and crop that can be enormously inflated. A second group—having large feet, a long beak, and a rough wattled skin about the eyes—includes the *carriers, dragons, runts,* and barbs. Another group, with short beaks and naked skin about the eyes, includes the fantails, turbits, tumblers, and frill-backs. Finally there are those that more nearly resemble the rock-dove—trumpeters, laughers, nuns, spots, and swallows. Next to the pouter, the fantail differs most from its original family, for it has from 36 to 46 quills in the tail, whereas the common rock-dove has but 12.

A carrier is a decorative pigeon raised mainly for show purposes. Pigeons bred and trained for racing or for carrying messages are termed homing pigeons. They possess a remarkable sense of direction and can be trusted to return several hundred miles to their home lofts. Caesar used pigeons as messengers during his Gallic wars, and the Saracens had a well-established pigeon postal service at the time of the Crusades. Thousands of "homers" are kept by clubs in America, and even more in Belgium, for the sport of pigeon racing. A speed of 60 miles an hour over a course of 75 miles is not uncommon; 40 miles an hour is considered good speed over distances of 125 miles or more.

During the first World War, where telephone and radio communication were not possible, the services of these feathered messengers won for them the praise and admiration of the world. All the armies made use of them. At one point 12 miles behind the French lines, the British kept 60 pigeons housed in a London motor-bus. The outside had been roofed to form their cage, while the attendants, consisting of a chauffeur, trainer, and orderly, slept inside. A perch was cleverly arranged before the opening in the front, so that when the birds alighted on returning from their flight, an electric bell aroused the men inside, day or night.

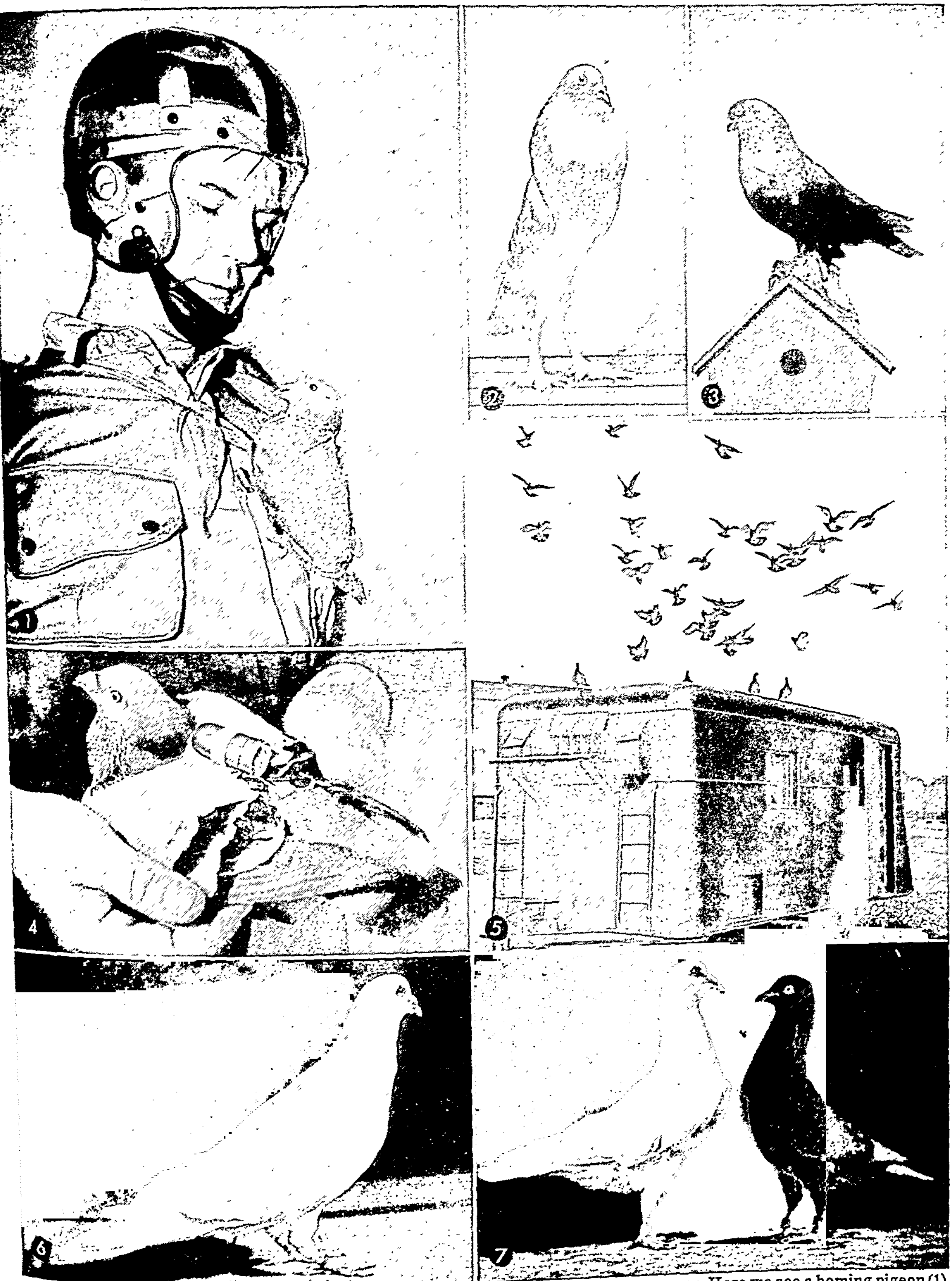
The pigeons were taken out to the trenches in baskets to serve as needed. If not used in 24 hours, they were released anyway with some message, to keep them in practise. Birds were always sent in couples with the same message, so that if one happened to be killed, there would still be a chance of the message arriving safely. An American pigeon, Cher Ami, brought help to the famous Lost Battalion of the 77th Division. Although seriously wounded when flying over the enemy firing line, he never wavered in his flight. When he died, his body was mounted and placed in the National Museum in Washington, D. C.

In the second World War military planes carried pigeons to summon help in case of crashes. The United States Army Signal Corps maintains a pigeon breeding and training center at Fort Monmouth, N. J., and has active pigeon lofts at a number of other posts. In peace time these birds are much used by the air service to establish communication in case of forced landings, especially in such regions as the Canal Zone, and the Hawaiian and Philippine Islands. Even the best of homers do not fly after dark, but the army is successfully developing a new race of night-flying homing pigeons that are vastly more useful as messengers in peace or war.

The raising of pigeons for food is common in Europe and America. The squabs, or young birds, when four weeks old, bring high prices in all markets. Pigeon nature demands sociability, and boys or girls who own a pair of pet pigeons often find that the birds will desert their private apartment for the crowded loft of a neighbor. Aside from providing salt, and water for bathing, the care of pigeons is similar to that of other feathered pets (*see* Pets and Their Care).

Pigeons and doves make up the family *Columbidae.* Scientific name of passenger pigeon, *Ectopistes migratorius;* of mourning dove, *Zenaidura macroura;* of rock-dove, *Columba livia livia.*

BIRDS OF WAR AND OF PEACE



Since the days of Julius Caesar pigeons have been used in war and in peace to carry messages. Here we see a homing pigeon (1) fastened in a harness on the chest of a paratrooper. He will be released with a message after the soldier lands. Another war bird (4) is ready to take off with a roll of 35-mm. film on its back. These military pigeons live in rolling homes (5). The remaining birds shown here are a red English pouter (2), a black muffed tumbler (3), a white Swiss mondaine (6), and a white king (7). The last two breeds provide squabs for the market.

PIKE. Fresh-water fish belonging to the pike family are ferocious in habits and appearance. They have undershot lower jaws, long narrow bodies, and only one fin on their backs. Their gray-green bodies with dark markings blend with the weedy waters along the shores of lakes and streams. There they lie in wait, ready to strike at whatever moves their way. Though pike are good to eat, they are regarded in some regions as pests because they destroy other game fish. In winter they seek deeper waters and are caught through holes cut in the ice.

Different Kinds of Pike

The largest member of the pike family and the mightiest of fresh-water game fish is the muskellunge. Specimens more than 5 feet long and weighing more than 65 pounds have been caught. Favorite fishing grounds are the waters of northern Wisconsin and Minnesota and of western Ontario, particularly in the region of Lake of the Woods. There, in the shallows behind log or rock, the "muskie" lurks, ready to catch passing fish, frogs, small water birds, or muskrats. It appears to seize the fisherman's lure more in savage resentment than from hunger. Once hooked, the fish lunges, leaps out of the water, and frequently ends the fight by shaking the lure out of its mouth.

The common pike, also called northern pike, pickerel, jackfish, and many other names, abounds in northern North America, Europe, and Asia. It may weigh 40 pounds, but a 10-pound specimen is considered fairly large. Anglers frequently confuse a large pike with the muskellunge. The pike's cheek, however, in front of the gill covers, is completely overlaid with scales, whereas in the muskellunge the lower half of the cheek is bare. Smaller members of the pike family are called pickerel (little pike).

The so-called walleyed pike is a member of the perch family. It has two fins on its back, the front one very large, with sharp spines. The gar pike, with long, narrow jaws that resemble a bill, is not a true pike but a member of the gar family.

Scientific Classification

The scientific name of the common northern pike is *Esox lucius;* muskellunge, *Esox masquinongy;* Chautauqua muskellunge, *Esox ohiensis;* chain pickerel, *Esox niger;* redfin pickerel, *Esox americanus;* grass pickerel, *Esox vermiculatus.* The last two are sometimes classified as varieties of the same species.

PILCHARD. These small, olive-green fish of the herring family (*Clupeidae*) are the basis of large commercial fisheries in many parts of the world. The United States pilchard fishery is confined to the species *Sardinops caerula,* which is found on the Pacific coast from southern Alaska to the Gulf of California. It is usually known by the name of *California sardine* or *Pacific sardine.*

For a number of years the catch of pilchards along the Pacific coast states was greater than that of any other species taken in the Western Hemisphere. In 1936 it reached a peak of 1½ billion pounds. In recent years, for reasons that are not entirely known, the fish have been greatly reduced in numbers, and in 1952 the catch was less than 10 million pounds. The fish are canned as sardines or are reduced to meal and oil. The meal and a portion of the oil are used for animal feed. The remainder of the oil goes into the manufacture of paint, soap, and many other industrial products.

Another kind of pilchard (*Clupea pilchardus*) is found chiefly in the Mediterranean Sea and off the west coast of France. Also known as sardines, these fish are canned in freshly pressed olive oil and command a comparatively high price in America. Sardines are so named because they were first caught in large quantities near Sardinia.

The female sardine lays 100,000 to 300,000 eggs a season, chiefly in April and May. The young hatch in three days and in about two months begin to form in schools. The commercial catch consists of fish two years of age and older, measuring 6 to 12 inches long. Pilchards reach the age of 15 years or more. They feed on small plants and animals and are themselves the food of many large fishes. They travel in schools near the surface of the water. A glow, made by luminescent organisms in the water stirred up by the schools of fish, reveals the pilchards to fishermen at night. By day, the schools look like blackish patches on the water. They are caught in huge nets called purse seines, 150 feet deep and a quarter of a mile long.

PILGRIMS. In the Middle Ages men and sometimes women often traveled long distances as pilgrims in order to visit spots made holy by their connection with the Christian religion. The tomb of Saint Thomas Becket at Canterbury, in England, and that of Saint James of Compostella, in Spain, were important places of pilgrimage. The most renowned were the shrines of the apostles Peter and Paul in Rome and the holy places of Palestine connected with Christ's life on earth. Hope of healing for souls or diseased bodies, a love of adventure, and the desire to see new lands all sped the pilgrims on their way to the sacred places.

Pilgrims were under the special protection of the church. The marks of a pilgrim consisted of the broad-brimmed pilgrim's hat—usually adorned on the return with sea shells and leaden medals of the saint—together with a staff, sack, and cup for drinking. Wealthier pilgrims rode horseback and often traveled in considerable companies, as described in Chaucer's 'Canterbury Tales' (*see* Chaucer). The poorer pilgrims traveled on foot. They lodged in monasteries or in separate "hostels" established for their aid, especially on the great Alpine passes, in the chief cities of Italy, and in Jerusalem. Pilgrims returning from Palestine usually carried palm leaves and hence were called "palmers."

Books were written as guides for the pilgrims, directing them as to their routes and telling, for example, how much they should pay for sea passage from Venice to the Holy Land and how they should prepare for the voyage. They must take with them featherbeds, with pillows, sheets, and blankets; and

they must take provisions for their private use, as well as necessary medicines. After landing, they must beware alike of foreign fruits and robbers. A list of phrases in foreign tongues was usually given, so that the pilgrim might ask his way and purchase necessary things. The stopping of pilgrimages to the Holy Land by the Seljuk Turks was one cause of the Crusades (*see* Crusades).

(For an account of the Pilgrim Fathers, who first settled Massachusetts, *see* the articles 'Mayflower' and Plymouth, Mass.)

PIN. Pins have long been so cheap and so numerous that it is scarcely thought worth while to pick one up where it falls.

In a normal year the United States produces an estimated 500 billion (half a trillion) pins. England is also a large manufacturer. Only one pin out of every hundred is worn out or broken in use. The other 99 are lost and oxidized (rusted) and so returned to the soil from which the ore came. The most important kinds are common pins, safety pins, and hairpins. Special kinds include hatpins and florists', glass-head, and tag pins.

Common and safety pins are made either of steel wire or of brass wire, and hairpins usually of steel wire. From the time the wire is fed into the machine until the pins are stuck into the paper strips, ready for packing, the action is automatic. Wire for the common pin is fed into a machine where it is cut into proper lengths, the heads formed by a die, and the points ground. The pins are then dipped in acid to clean them and after that they are coated by immersion in molten tin. Pushed along slowly until the tin coat hardens, they then drop into a revolving barrel of bran which cools and polishes them. Next they are fed into a hopper with a steel plate at the bottom, cut into slits just big enough to allow the bodies of the pins to fall through, but not the heads.

Thus straightened out in rows, the pins move toward the edge and slide down an inclined plane. At the bottom are the strips of paper, in which the pins are caught and inserted. The mechanism is so delicate that the least imperfection in one pin will stop the feeding until the obstruction is removed. One of these machines will stick 100,000 pins an hour.

The safety pin was patented by Walter Hunt, of New York, in 1849. He probably did not know that it had been in use 2,000 years before Christ by Bronze Age peoples, by the ancient Etruscans, and by the men and women of early Greece. In Egyptian tombs ornamented straight pins of brass, gold, and silver have been found. Various species of thorns were often used as pins by early peoples.

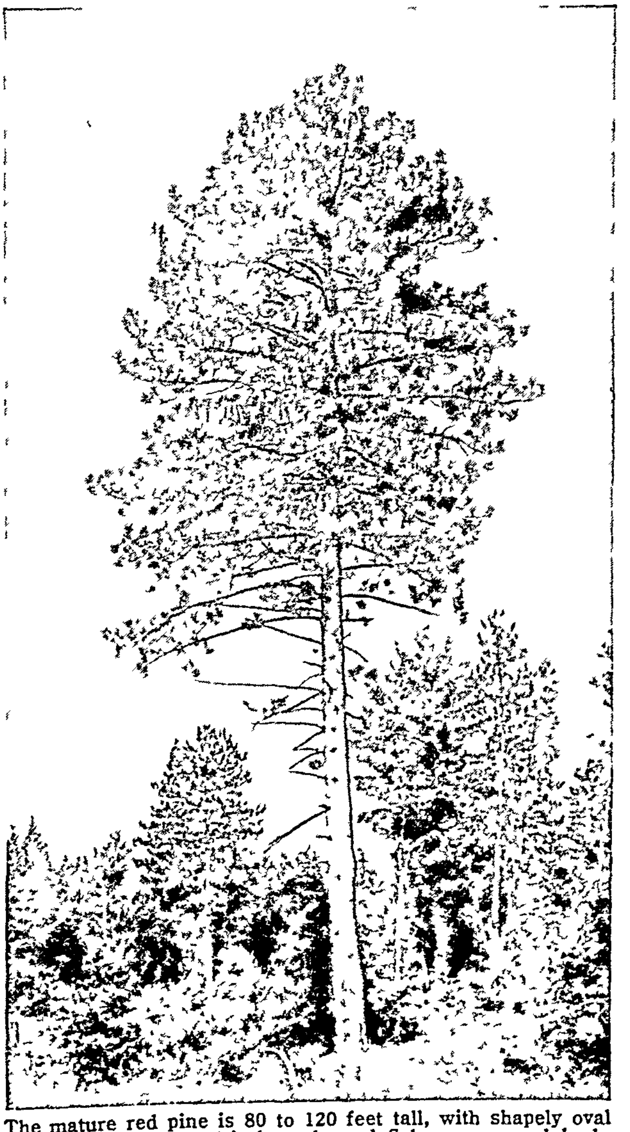
In 1372 the pinmakers of London formed a guild. Pins were few in number and highly prized. It was the custom for a man to provide in his will a special bequest enabling his wife to "by her pynnes"—hence the expression "pin money." It came to mean any sum allotted to a woman for personal expenditures.

In Revolutionary War times in the United States the heads of pins were made by twisting fine wire into a knob and soldering it firmly to one end. The first machine for making solid-headed pins out of a single piece of wire was invented by Lemuel W. Wright, of New Hampshire, in 1824.

PINE. Of all our forest trees, the pines are among the most beautiful and the most useful to mankind. They are distributed throughout the Northern Hemisphere from the tropics to the limit of tree growth beyond the Arctic Circle. In size they range from a few feet in height to species towering 200 feet or more. They frequently form extensive forests of stands almost unmixed with other kinds of trees.

The pine family *Pinaceae* includes six genera of evergreens: *Pinus* (the true pines), *Larix* (larch), *Picea* (spruce), *Pseudotsuga* (Douglas fir), *Tsuga* (hemlock), and *Abies* (fir). Nearly 40 species of *Pinus* are native to the United States and Canada. Twelve species are found in the East and South. The remainder occur in forests of the Western states.

A TOWERING RED PINE



The mature red pine is 80 to 120 feet tall, with shapely oval crown, straight, cylindrical trunk, and flaky orange-red bark. The needles, 4 to 6 inches long, are in bundles of two.

The most common species in the United States is the white pine, a magnificent tree attaining a height of 80 to 175 feet. The branches, whorled horizontally about the splendid erect columns, are densely clothed in bluish green and gray needles, growing in small clusters of five needles each. The tree tapers gracefully and is very picturesque. It bears long slender solitary cones which are slightly curved. The bark is greenish-gray and rather smooth on the younger trees, becoming rough and brown with age. The tree is a favorite with lumbermen because of its strong, clear-grained, easily worked wood, and consequently is much rarer than formerly.

WHY PINES ARE SUCH MOUNTAIN CLIMBERS

"The pine trees," said John Muir, the famous naturalist, "march up in long, hopeful files, taking the ground and establishing themselves as soon as it is ready for them." Haven't you often wondered why pine trees are such mountain climbers? The picture tells you this, among other things. The two great trunks are those of the white pine, while in the group to the left are mature cones, clusters of needles, young cones, and the winged seeds, some with the wings detached. By their wings the seeds are carried with the wind up the mountain sides. It is really wonderful how little soil a pine tree can get along with, if its fortune is cast on some mass of mountain rock.

The red or Norway pine is also a beautiful tree, having reddish brown bark from which it gains its common name. Though often attaining the height of the white pine, it is sometimes rather dwarfish. The branches are few and the needles, which grow in clusters of two, form sparse clumps at the ends of the short twigs. The appearance of the tree is rather light and airy. It bears small oval-conical cones.

The Southern yellow pine or long-leaf Georgia pine is remarkable for its needles, which are often a foot in length, growing in clusters of three. It is a very slender stately tree, rising to a height of 50 to 120 feet. The trunk is bare of limbs to a great height, and is covered with orange-brown bark which separates into scaly plates. The cones are large and coarse.

The western yellow pine or ponderosa, often called the great yellow pine, is a veritable giant. Many of these trees grow to 150 feet in height, and some soar to 230 feet. The needles, which grow in clusters of three, are long and twisted; the small oval cones have recurved prickles.

The loblolly pine covers great areas in the Southern states. It is very hardy and frequently springs up in devastated and impoverished land. It grows to a height of 80 to 90 feet and sometimes has a girth of six to eight feet. The needles are rather long, growing in groups of three, and are light green in color. The cones grow in pairs and are quite large.

The Scotch pine, an important species introduced into America from northern Europe, has dark green needles growing in clusters of two, and small compact cones. The piñon or nut pine, found in the southwestern United States and Mexico, is a small tree with a bushy top. Its rounded cones produce large seeds which formed an important diet for the Indians.

Pines are valued for the durability and the attractive grain of their wood. They have long supplied most of the softwood lumber produced in the United States. The billions of board feet used each year for such purposes as beams, house frames, furniture, and interior finish come mainly from the various Southern pines, the western yellow pine, and the white pines. The more resinous of the Southern pines supply many industries with huge quantities of naval stores—resin, tar, and turpentine (*see* Turpentine). The Southern pines, notably the slash, the loblolly, the long-leafed Georgia, and the shortleaf, are important as a source of paper (*see* Paper). They have made the South the center of the coarse paper (kraft) industry, which annually produces containers and wrappers valued at many millions of dollars.

The Southern pines are coming into use also for the manufacture of newsprint paper, thanks to patient research by Charles H. Herty, a Georgia chemist. His discovery that young pines, which have no value for timber or resin, make satisfactory newsprint has given commercial importance to millions of wooded acres and has laid the foundation for a promising newsprint industry in the Southern states.

True pines are readily distinguished from spruces, firs, larches, and cedars by their foliage and cones. The leaves, which are evergreen, are needle-shaped and measure from a little more than an inch to more than a foot long. They grow in clusters, usually of two to five according to the species, sheathed at the base by thin chafflike scales. The cones are pendulous, and the woody cone scales are thicker at the top. (For commercial uses of pine, *see* Wood.)

The scientific name of the white pine is *Pinus strobus;* range, Newfoundland to Manitoba, the Alleghenies to Georgia; red or Norway pine, *Pinus resinosa;* same range as white pine; southern yellow pine, *Pinus palustris;* range, North Carolina south to Texas; western yellow pine, *Pinus ponderosa;* range, British Columbia to Mexico, east to Nebraska; loblolly pine, *Pinus taeda.* (*See* in FACT-INDEX names of pines.)

PINEAPPLE. Once a rare delicacy, the pineapple has become a familiar fruit in North America and Europe. It was found in various parts of Latin America by Christopher Columbus and later explorers. Now it is grown in many tropical lands. The Hawaiian Islands, Cuba, Mexico, and Puerto Rico have made its production for export a specialized industry. The fruit can be grown in the United States only in the most nearly frost-free parts of southern Florida.

THE FRUIT THAT LOOKS LIKE A PINE CONE

Here is an Hawaiian pineapple, packed full of sweet pulp and juice. Notice its resemblance to a pine cone, from which it gets its name.

As a pineapple plant stands in the field, with its fruit rising out of a cluster of long sword-shaped leaves, it looks somewhat like a cactus. Each plant bears one fruit for the first crop. Later crops, which grow from sprouts (called "ratoons") on the stem below ground, generally yield two smaller fruits to the plant. The "fruit" is really a cluster of fruits, as is the case with blackberries and raspberries. Each "eye" in the horny outer rind is the product of one blossom.

Cultivated pineapples rarely produce seed, and the plants are grown from cuttings. These may be "slips," which grow in clusters near the base or near the top of the fruit; "suckers," which develop in the axils, or pockets, of the leaves; or "crowns," the leafy tufts at the top of the fruit.

Though pineapple plants need little water and only fair soil, the land has to be heavily fertilized, and the plants are usually sprayed with insecticides and hormone preparations. Hawaiian planters lay strips of heavy asphalt mulching paper over the soil and plant the cuttings through holes in the paper. This method is expensive, but it keeps down weeds and conserves moisture and heat. The fruit ripens 14 to 22 months after planting. In gathering the first crop, Hawaiian growers usually leave two ratoons to each plant for the second crop. A third crop is produced in the same way. After three or four years the planter starts again with cuttings.

Introduction into Hawaii in 1886 of the Sweet Cayenne, a richly flavored, nonwoody variety, marked the beginning of the pineapple industry there. Producers in Hawaii can most of the pineapples they raise, because the fruit bruises so easily that shipping is difficult. Cuba, Puerto Rico, and Mexico supply most of the fresh pineapples eaten in the United States. These are mainly of the Red Spanish variety and are seldom fully ripe when picked. They therefore lack the rich flavor of Hawaiian pineapples.

The long, tough leaves of the pineapple yield a fiber which in the Philippines is woven into fabrics. A delicate transparent cloth known as *piña* is made from the finer fibers.

The pineapple (*Ananas sativus*) belongs to the pineapple family, the *Bromeliaceae,* which includes the bromelias and Spanish moss.

PINK. Much of the spicy fragrance in old-fashioned gardens comes from the fringed-petal flowers called pinks. A favorite species is the clove pink, which in its cultivated double form is known as the carnation (*see* Carnation). Another favorite is the sweet William, whose blossoms are marked with white and various tints of red. Other familiar garden pinks are the sweet-smelling common pink, which has gray-green leaves and pale pink and white flowers, and the China pink, which bears strangely-marked red blossoms throughout the summer.

The pink is a genus (*Dianthus*) of the family *Caryophyllaceae.* The many species, which are mainly perennials, are natives chiefly of southern Europe, North Africa, and temperate regions of America. The pink's flowers may be solitary or clustered. The leaves are narrow and grasslike. Some wild flowers which belong to this family but to a different genus are also called pinks. Among them is the fire pink (*Silene virginica*), whose showy bright-crimson flowers bloom in early spring.

The grim, watchful backwoodsman is ready with his Kentucky rifle for Indians. Meanwhile, the other man toils to make a farm out of newly cleared land. The fort and the stockade serve as refuge and shelter. Watch and work—these two activities formed the very essence of early pioneering in the United States. The picture is from a painting by Stanley M. Arthurs.

HARDSHIPS *and* HEROISM *of* PIONEER LIFE

THREE centuries ago, the American continent was a wilderness of forests, prairies, and mountains. Indians roamed everywhere; but probably the entire continent did not support many more people than live now in Cleveland, Ohio. Today the United States alone supports about 150 million people, with a rich civilization. What produced this amazing change? Inventors, builders, and businessmen helped with many improvements; but their work rested on the foundations laid by the land-settling pioneers who kept pushing westward until they had turned the entire wilderness into a civilized land. Therefore, to understand the United States of today, we should understand these pioneers, their lives and struggles, and how they finally succeeded with their tremendous task.

How the pioneers started their work on the Atlantic coast is told in the article on American Colonies. Until the colonies won their independence from English rule, the people remained near the Atlantic; but when the United States won its freedom, it also won a vast forest wilderness to the westward. Then began the kind of pioneering about which this article tells.

Equal partners with the men in work and danger were the pioneer women. Here the artist Gari Melchers has given us a superb study of such a woman gripping a mattock, or grub hoe—toil-worn but invincible.

PIONEER LIFE. When the American people started pushing west from the Atlantic coast into new lands, among the first to go were backwoodsmen from western Virginia and North Carolina. Daniel Boone had told them about fine land in Kentucky; and even before the American Revolution ended, some had started for this land.

A group of pioneers starting into the wilderness was a thrilling sight. In addition to women and children, a party usually included about 30 or 40 men and boys, carrying rifles. Many fighters were needed because the Indians were not friendly, as they had been at first to hunters and trappers. They knew that the pioneers would make farms which would ruin the country for hunting. One group of riflemen marched ahead; the rest watched the live stock and guarded the rear.

Ahead of them lay the hardest kind of traveling, over rugged mountains and through thick forests. They had heard from Boone of a low pass over the mountains at Cumberland Gap; but the trees were so close that men could scarcely squeeze between. Vines, underbrush, and fallen trees added to the tangle. The only way to get through without chopping a path was to follow the Indian trails.

These trails began as animal trails. Even when the forests were young, deer and bison roamed over the land, seeking fresh pasture and avoiding winter cold. Instinctively the animals used the lowest passes over the mountains, and kept near water. Their hoofs beat down all growth along their lines of march, and so trails were kept open as the forest grew.

Of course carts or wagons could not be used on such trails. Everything had to be carried on pack animals. Women and young children might ride these animals; but this added to the load and made the going slow. The party might march ten miles in a day, or even less if they had to chop away fallen timber from the path.

Late in the afternoon, the advance guard selected a good spot and made camp for the night. Some men kept watch, while others cut branches and built a windbreak. The women cooked supper. They made johnnycake by baking a batter of corn meal on a stone in front of the fire; they cooked venison or other game by broiling chunks held on sharpened sticks over the coals. After supper, the men posted sentries to watch the live stock and to give warning of Indians. Then the camp settled down to sleep, with the creakings and whispers of the forest for a lullaby.

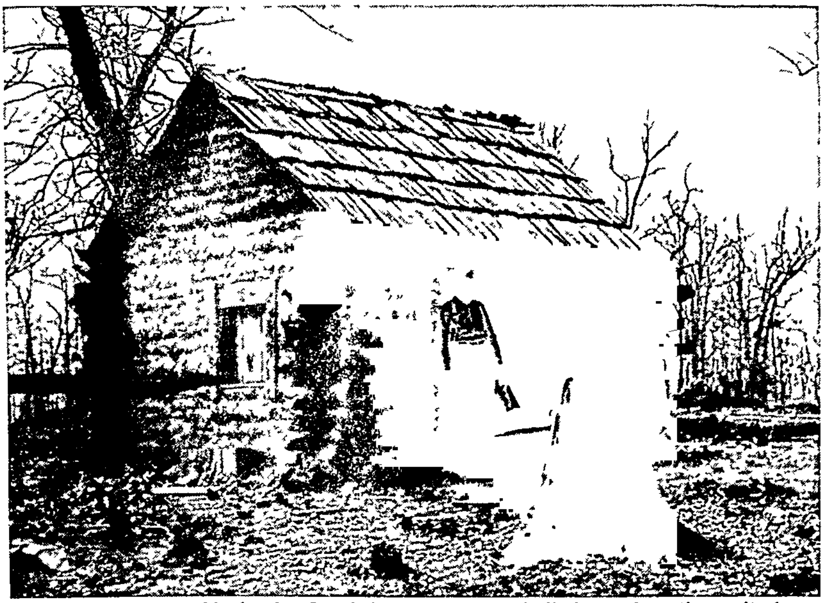
Building a New Kentucky Home

Pushing forward slowly in this toilsome, dangerous fashion, the newcomers hoped to reach one of the little settlements already established by men like

Boone. There they knew they would find a blockhouse fort, where everybody could take shelter if the Indians attacked. Without such a place of safety, none of them could hope to live through a season.

Day after day, they pressed on toward the fort. After a month or two of hard travel, they reached it. Then the men looked over the ground and drew lots for choice of land. Each man marked the boundaries of his claim by cutting his initials in trees.

A LOG CABIN OF THE PIONEER TYPE



Although this log cabin in the Ozark Mountains was built in modern times, it shows the true pioneer method of building, with its dovetailed logs, its mud chinking, and its slab roof. The early Kentucky settler, of course, had no "store" lumber for his door or his window, nor did he have "store" clothing.

All the men and older boys helped to build log cabins. For two or three days they cut trees into logs, and rolled the logs to the building site. The logs were cut about 20 feet long for the sides, and 16 feet long for the ends. Four big logs were placed on the ground for the foundation. The men notched the ends with axes and fitted them together. Next they laid a floor of stout poles crosswise between the longer logs. When the house was built, the owner covered the poles with roughly hewn slabs called *puncheons*.

More logs were laid and dovetailed at the corners until the walls were high enough. Then the builders laid crosswise poles for an attic floor. To start the roof they set up stout poles called *rooftrees* at each end of the cabin. Each pole had a Y-shaped fork, in which the *ridgepole* was laid. The men cut slabs from large trees, and laid them from the topmost side logs to the ridgepole. Across these slabs they laid poles and fastened them with wooden pegs, to hold the roof against wind.

Cutting openings for windows and a door finished the heavy work. The job was done in a week, or even less, if eight or more men helped. Later, the owner did his chinking—that is, he filled in the spaces or chinks between the logs with wooden chips, moss, and clay. He laid stones for a hearth, and built a chimney of sticks daubed thickly with clay.

The door and the window shutters were slabs of wood with deer-hide hinges. These could be kept closed by stout bars on the inside that swung at one end. To open the door from the outside, there was a *latchstring*. This was a thong of deer hide attached to the bar and passed through a hole in the door Pulling it raised the bar so that the door could be opened. When troublesome Indians were about, the latchstring was pulled in at night; otherwise it was left out, so that neighbors could enter. Hence the saying, "the latchstring is always out," came to mean generous hospitality. There was no glass for the windows, but the openings were sometimes filled with greased paper or deerskin. This let some light into the cabin and kept out wind and insects.

When the owner found time, he made chairs and a bed; but most of the first season was spent in clearing land. He cut down and burned the trees. Between the stumps he planted corn, wheat, or buckwheat, and he cultivated the crops with a hoe. In most places the pioneer farmer could not plow for several years. He had to wait for the roots of the stumps to rot so that they could be grubbed out.

The Early American Pioneers

How did these people learn to get along so well in the wildernesses of Kentucky and Tennessee? They learned from their parents and grandparents, who had been pioneers in western Virginia and North Carolina That first wave of pioneers was made up of people who disliked conditions in the older settlements near the coast. They objected to government policies, they resented being thought inferior to the rich colonial merchants and landowners, and they wanted farms of their own. Though poor, they were daring and energetic. After about 1700, those early pioneers began to go to the western edges of the colonies to start a new life.

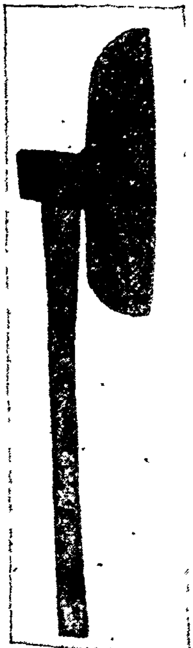
In all these pioneer settlements in forest lands, the people and their ways of living were much alike. To survive, they had to be strong and hardy. As a rule, they were quiet folk, who rarely expressed joy, sorrow, fear, or pride. But nothing in nature or the behavior of their fellow men escaped their keen notice They had no money or salable property, so thefts were almost unknown. Every man trusted to his fists and his rifle to protect his rights, for it was long before law courts were set up.

Most of the pioneers were deeply religious, but they could not support ministers. So the older men

took turns preaching on Sundays. At rare intervals a *circuit rider*, or traveling clergyman, might come by, preach on Sunday, and perform marriages and baptisms. These ministers might be paid a hundred dollars or so a year by the settlements along their circuits or regular paths. They were guests of each settlement in turn. So, too, were all travelers who came by; backwoodsmen, as these people were called, were insulted if anyone offered them money for a night's lodging.

Home Life in the Log Cabins

In such settlements, people had little use for money. Once a year or so they might trade furs and perhaps some farm produce for powder, lead, iron, and salt. Their own gunsmiths and blacksmiths made their rifles and tools.



A broadax, of the type used by early pioneers for hewing logs into beams and similar shapes.

In the division of labor, every man, woman, and child shared fairly. The men and older boys provided the food by hunting and farming, chopped up trees for fuel, and made the furniture and household implements. For chairs, they merely stood hickory blocks on end, or made three-legged stools. Some of the slab tables had one side supported by the wall and the other held up by two sticks; others had four legs. The men made beds by laying slabs on a frame, and for mattresses the women stuffed sacks with chaff, moss, or pine needles. The men whittled out wooden forks and spoons, and made spinning wheels and looms. Women, girls, and young children did the cooking and made soap, candles, and clothing. The boys "jerked" venison, by drying thin strips of the meat before the fire or out in the hot sun. This prevented decay. The dried strips were hung in the attic until needed.

The women made their own clothing of *linsey-woolsey*, a cloth they wove from flax and wool. They often dyed it yellow or brown with juice from butternut bark and husks. The men wore some linsey-woolsey, but they liked deerskin for outdoor clothes. They ornamented the seams and edges with colored fringe. Caps were made of raccoon skin, with the tail left hanging. When away from home everyone wore moccasins, but around the house the women and children frequently went barefoot.

The cabins never stood far from a stream or spring, because the women and children could not risk long trips through the perilous forest for water. The clearing around the cabin was their safeguard; it gave them a chance to see Indians or wild animals before they could get very close.

In good weather the newest baby was usually put outside the door in an Indian-style cradle. This was made of smooth wood and lined with pelts and a bit of blanket. Children had no toys; the parents could not spend time making such luxuries. Older children ground corn on a flat stone, with a round stone bound to a stick. They tended the small garden, planted with squash, indigo, beans, flax, sorghum, and gourds. The gourds were used for cups and bottles; handles for the cups were made with twigs.

A typical cup of a pioneer family made from a long-stemmed gourd by a little trimming and hollowing out.

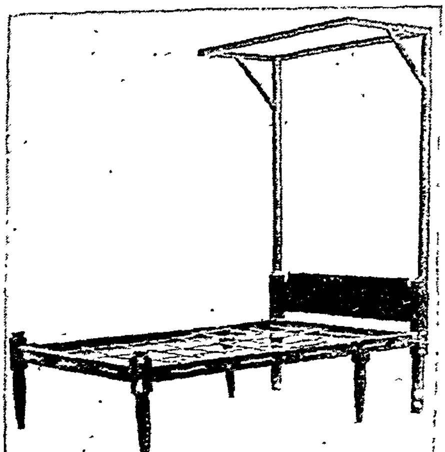
Indoors, the wife always kept the fire burning. In summer, no other light was needed; the family rose before dawn and went to bed at dark. In winter, they burned rush lights, pine-knot torches, or tallow-dip candles. For special occasions some had waxy and sweet-smelling candles made of bayberries.

A bearskin rug lay before the hearth. Above the doorway was a pair of deer antlers. On these the family rifles lay when they were not in use. A powder horn hung from a prong. Near the guns, a mold for making bullets nestled between two logs.

The family had no sheets, no tablecloths, and no towels. They washed in a bucket, with strong, homemade soap; they bathed in a near-by stream or spring.

Food and Cooking

Until the family got vegetables from the garden and corn from the clearing, they lived on cow's milk, game, and berries. Sometimes the children grew so tired of wild meat that they cried when it appeared on the table. Since wheat was too hard to grind without a regular mill, corn was the staple food.



This bed, with its canopy frame and springs of criss-crossed rope, is typical of pioneer beds in the old Northwest.

Young, ripe corn was eaten as roasting ears. In winter the husks of the kernels were soaked off with lye to make hominy. For breakfast and supper there was boiled corn-meal mush. Sometimes the mush was fried and served with butter or pork drippings. The most common dish, however, was hot corn bread. Baked on a hoe blade before the fire, this was called *hoecake*. Mixed with water into a stiff batter and covered with hot ashes, it was *ash cake*. From the Dutch oven it emerged as *corn pone* or *corn loaf*. Small cakes of corn pone were called *corn dodgers*.

In time, chickens and eggs added a little variety to the menu. The most important meat animal was the hog. Coffee and tea were rare luxuries. Sometimes the mother made hot, coffee-like drinks of dried wheat, barley, or certain roots roasted and ground. Sugar was so scarce that it was used only for the sick or for a celebration. Instead the family used maple sugar, or wild honey, or sorghum sweetening. This last was sometimes called "long sweetenin' "; it was black and thick and tasted slightly bitter.

Salt was expensive. It was usually packed on horses, and it sold for $10.00 a barrel. Many families used no more than a pound of salt a year. Some got salt of poor quality from near-by salt licks. Pepper and other spices were practically unknown.

Life of the Pioneer Woman

The pioneer woman found life less interesting, more monotonous, and lonelier than did the man. Household tasks kept her indoors or near the house—cooking, cleaning, washing, mending, baking, spinning, and weaving. She had none of the conveniences that lighten the burden of household tasks today. For example, she had to make her own broom out of corn husks, or by shredding a hickory pole, fiber by fiber, until the brush at the lower end was fairly fine. Then she bound the fibers together with hickory splints.

The women also did most of the doctoring and nursing. They could probe for a bullet with some skill, trim a wound with a knife, and sew the edges together. They dressed wounds with a salve made of pounded slippery elm bark, and with bear's grease. They knocked out bad teeth with a hammer and a chisel. Almost every mother could help at childbirth, for doctors could not be had.

When a boy was 14 he was considered grown, and his father gave him a rifle. Most young people were married when not much older. Children got whatever schooling they had from their mothers and aunts.

Settlers in the Old Northwest Territory

Pioneers did not settle north of the Ohio River as soon as they did in Kentucky and Tennessee, for several reasons. Many of the early pioneers went no farther than the fertile valleys of the mountains in the East and New England's new shipping trade gave work to many men who might otherwise have moved to the West. Besides, several states claimed the northwest region, and so settlers hesitated to take up land until they knew what authority would give them titles.

In 1787, however, the Continental Congress created the Northwest Territory, to include all land north of the Ohio and west of Pennsylvania, and encouraged settlers to move in (*see* Northwest Territory; Lands, Public). Immediately a flood of settlers began pouring in from the northern states, and from Maryland and Virginia.

Not many of these settlers were experienced backwoodsmen, like the people who settled Kentucky and Tennessee. Though most of them were country folk, who knew how to build a log cabin, clear land, and make their own clothing, they were not content with the prospect of living as pioneers all their lives.

Back home they had become accustomed to selling some of their crops for money, and they had been used to wagons and roads. Most of them brought a few cherished possessions—a small chest of "party clothes" for the women and girls, perhaps a "Sunday suit" for the father, dishes, and possibly even a four-poster string bed.

The journey into the Northwest Territory was a little easier than the trip into Kentucky, because the settlers could travel part way by water. People from New England and New York could cross northern New York and then sail along Lake Erie until they reached one of the lake towns or trading posts. People from farther south reached the Ohio at Pittsburgh, then used the river.

Early Boats on the Ohio

For two-way travel on the river they used dugout canoes, keel boats, and flat-bottomed batteaus, as they had on eastern rivers. But most of the newcomers built or bought boxlike arks or flatboats and drifted downstream. These craft could be steered and worked in to a landing with long oars, called sweeps, if the current was not too strong. But often strong currents spun them about like corks, or carried them past their landings.

Another danger was the Indians, until they were pacified by the Treaty of Fort Greenville in 1795. Many an ark went down the river like a floating fort, with rifles blazing through portholes at redskins along the shore. White pirates also plundered boats and killed people, until the Kentucky militia cleared them out at Cave-In Rock, below Shawneetown, Ill. After that, the worst danger was from snags or from drifting trees which had caught fast on the bottom.

Despite these dangers, the pioneers had a great deal of fun on these river trips. Sometimes the boys might fish, while the women busied themselves with cooking and mending or knitting. When the day's work was done, some member of the party might produce a fiddle and they would end the day with singing and dancing.

Trading Problems in Early Days

After these settlers arrived on their land, their life for the first few years was much the same as early life in Kentucky. They had to build cabins, clear land, and hunt or fish to add to their scanty food supplies. To get money, they floated grain, salt pork, and other products downstream to markets along the lower Mississippi. They either walked back or *poled* a boat.

To pole a boat, the men started at the bow of the boat and pushed iron-tipped poles into the bottom of the river. Then they walked to the stern, pushing as they walked. This way of travel was slower than walking, but it enabled them to carry supplies back home.

Supplies could also be bought from peddlers with pack animals. Settlers near the Ohio could buy from

TRAVELING DOWN STREAM IN A BROADHORN

Here a group of pioneers, with their goods and live stock, is drifting down a western river toward a new home. The men and older boys work the steering sweeps, while the women care for the children and live stock or watch the scenery from the roof. The boat is of the flatboat type; but it was called a "broadhorn" when it had steering sweeps at the sides.

boats that plied up and down the river. They were fitted up and stocked like country stores, with cloth, crockery, pins, tinware, hats, and other "store goods."

Coöperation in the Northwest

Pioneers came to the Northwest Territory in greater numbers than to Kentucky, and the northern settlements were larger. As a result, there was even more coöperation between neighbors here. When a new settler came, the neighbors helped him build his log cabin by a "house-raising" party. Later they had a "log-rolling" party to help him clear his land. The women had quilting bees and other gatherings, as the women had had in Colonial times. But the greatest cooperative effort came at harvest time. At break of day the harvesting crew assembled with scythes or cradles. At the word of the leader they started to cut, advancing in rows and working until the leader gave the word to rest or until they had to whet their blades.

After the small-grain harvest came the corn harvest. The corn was cut by hand with a long knife and stacked in shocks. Later the ears were husked, or stripped of their covering, at a husking bee. The men worked in two teams. They laid a pole along the pile to be husked, and the crews started at opposite ends. The teams joked and played tricks on each other as they husked, while the women and children cheered. The winners celebrated by carrying their captain around the yard, singing and yelling as they went.

Amusements and Celebrations

After a house-raising or a husking bee or any of the many other "bees" for coöperative work, there was usually a "social" for all—men, women and children. First they ate a huge supper. Then, as the flames of a great log fire flared up, the fiddler tuned up, and the people began to dance. The star dancer or couple would execute a jig or a buck and wing to the accompaniment of clapping hands and stamping feet. Couples formed into sets for a square dance, under directions from a caller. The fiddler had the privilege of taking the prettiest girl to supper.

Similar celebrations were held for weddings and christenings. People came long distances, dressed in their best. When they neared the host's house, they bathed their feet in a stream and put on their shoes.

When no celebrations were being held, the people welcomed any wandering peddler or fiddler, or any stranger who could tell a good tale (*see* Appleseed, Johnny). The young men delighted in contests of strength. After a week of hard labor they often spent Sundays and holidays broad jumping, vaulting, running, lifting, wrestling, and boxing. Horse racing, cockfighting, and shooting matches were other amusements.

The Evil Side of Frontier Life

These sturdy pioneers had many difficulties to face, in addition to their struggle to make a living. Many troubles grew out of the government method of selling land. For many years, the land offices were in the East. A settler either had to buy before he started West, or he had to go West to select his land and then come back to buy. This opened the way for speculators to buy huge tracts of good land and hold it for stiff prices, and also made possible many frauds. The government at first sold its public lands at a minimum of \$2.00 an acre. After 1820 it lowered the price to \$1.25.

Many a settler, having spent his money for supposedly good land near a growing town, arrived with his family to find that his land was in a malaria-ridden swamp, or even under water. Strangely enough, such

swindles were not condemned by public opinion, or punished by the courts. Although most of the pioneers were honest in their own dealings, they were "Yankee traders" at heart, and admired anyone who got the better of a business deal. They thought that land sharpers, shyster lawyers, and even counterfeiters were "cute" and "smart."

Charles Dickens, in his novel 'Martin Chuzzlewit', describes a fever-ridden and ruined victim of a land swindle, who nevertheless laughed at an Englishman for being taken in. The pioneer remarked that the swindler "was a smart man, and had draw'd a lot of British capital that way, as sure as sun-up." The United States was to suffer heavily, and still suffers, in business, public affairs, and administration of the law, from this pioneer admiration for winning out, no matter how.

Rough-and-Ready Justice, Courts, and Law

The pioneers looked to their fists and weapons more than they did to courts and laws for protection of their rights. Fights were common in towns and in community gatherings. They were even regarded as sport. One English traveler wrote: "America is the country where life is held cheaper than anywhere else. . . . When men fight in the States they fight in earnest. . . . Revolvers are forever revolving. There is no objection to fowling pieces, to rifles, to bowie knives." A story is told of a prisoner in a frontier jail who offered to fight all comers, if he could go free upon beating every opponent; the community is said to have accepted the offer as thoroughly fair and proper.

John Reynolds, in 'My Own Time', tells of rough-and-ready ways in the early courts. When he was about to open a session in one court, the sheriff, astride a bench, called out: "Boys, the Court is now open; John is on the bench." An Illinois observer tells how a certain judge responded to the lawyers' appeal to instruct the jury. "Why, gentlemen," he said, rubbing his head, "the jury understand the case; they need no instruction. No doubt they will do justice between the parties."

Court sessions were often held in a log cabin or a schoolhouse or a tavern. Lawyers and judges "rode the circuit" together. Their fees were ridiculously low; but they did not expect to make a fortune out of practising law. They used their profession as a means of getting ahead in politics and finally being elected to the state legislature or the national Congress. By riding the circuit, and proving themselves "smart" in court, they won friends among the voters.

New Frontier Beyond the Mississippi

BY 1840 MOST of the good land north of the Ohio and east of the Mississippi had been settled. The regions beyond these rivers called for a different type of pioneering. The prairies of the West seemed utterly unfit for farming to the men of that day. A country which had no trees, except for cottonwoods along the river bottoms, seemed to them a country too dry for crops. Geographies as late as 1870 labeled the region east of the Rockies "the Great American Desert."

The Indians, too, were an obstacle to settlement. The government had agreed that this land was theirs, and that no white man could enter without their permission, except to travel over certain routes, such as the Santa Fe Trail. The Indians threatened to fight rather than admit settlers. The only white men in the region were fur trappers and traders. Some of them lived here because they liked the open, wild life; but many were criminals who dared not return to the East.

The Covered-Wagon Rush to the Pacific

This indifference to the West changed in the winter of 1842–43, when Congress discussed a bill to provide land for settlers in Oregon. In the spring of 1843 a great rush to Oregon set in. This rush was different from any earlier pioneer movement.

The earlier migrations had been over cramped forest trails with pack animals or along rivers, such as the Ohio. But here no river between the Missouri and the Columbia would take a boat larger than a light canoe. Instead of forest trails, the pioneers had a broad, flat prairie for much of the way, and they could use *covered wagons* or *prairie schooners*, which developed from the Conestoga freight wagons used in the East.

Without wagons they could not have made the long journey, for they had to carry supplies enough for several months, as well as weapons and tools. A common list of supplies for one person was 150 pounds of bacon, a barrel of flour, a half-bushel of beans, 10 pounds of rice, 20 pounds of coffee, 20 pounds of sugar, a year's supply of cloth, 2 blankets, 4 pounds of gunpowder, and 12 pounds of lead for bullets. The wagons carried the women and children and this made travel faster. By drawing the wagons together in a ring at night, the pioneers had a good defense against Indian attacks.

Marching in Caravans with Covered Wagons

To make the most of these advantages, settlers organized caravans of from 20 to 100 wagons, and maintained something like army discipline, with a captain and other officers. The following account of a typical day is condensed from a description by Jesse Applegate, a captain who led a group in 1843:

> It is four o'clock A.M.; the sentinels on duty have discharged their rifles and every wagon and tent is pouring forth its night tenants. Slow kindling smokes begin largely to rise and float away in the morning air. Sixty men start from the corral, spreading . . . through the vast herd of cattle and horses that make a semicircle around the encampment, the most distant perhaps two miles away.
>
> By five o'clock . . . the teamsters are busy selecting their teams and driving them inside the corral to be yoked. . . . From six to seven o'clock is a busy time; breakfast is to be eaten, the tents struck, the wagons loaded and the teams yoked. . . . All know that at seven o'clock, when the signal to march sounds, those not ready to take their places in the line of march must fall into the dusty rear for the day.
>
> It is within ten minutes of seven. . . . The pilot, a borderer who has been chosen for his experience in travel through roadless wastes, stands ready in the midst of his pioneers and aids, to mount and lead the way. Ten or fifteen young men are ready to start on a buffalo hunt. The cow drivers are hastening to the rear of their charge, for the day's march.

HOW THE COVERED WAGONS CROSSED PRAIRIE RIVERS

Perhaps the most back-breaking work during the entire journey to Oregon or California was crossing rivers and streams. Men and animals strained to the utmost, as we see them doing here; and often an entire day was spent in getting a caravan across.

It is on the stroke of seven. The clear notes of a trumpet sound in front; the leading divisions of the wagons move out; the rest fall into their places with the precision of clockwork.

The pilot [selects] the nooning place as nearly as the requisite grass and water can be had at the end of five hours' travel of the wagons. Today. . . . he and his pioneers are at the nooning place an hour in advance of the wagons . . . . preparing convenient watering places for the animals, and digging little wells near the bank of the Platte. A corral is not formed at noon. The wagons are drawn up in columns, four abreast. . . .

The sun is now getting low in the west, and the pilot is standing ready to conduct the train in the circle which he has previously measured and marked out. The leading wagons follow him; each wagon follows, the rear closing on the front, until its tongue and ox chains will reach perfectly from one to the other; and so accurate the measure and perfect the practice, that the hindmost wagon of the train always precisely closes the gateway. Within ten minutes the barricade is formed, the teams unyoked and driven out to pasture. Everyone is busy preparing fires to cook the evening meal, pitching tents and otherwise preparing for the night.

Crossing a Western Prairie River

In this way the pioneers marched day after day and week after week, except when they had to cross a river. In the prairie country the rivers are wide, shallow stretches of muddy water, flowing lazily over mud, sand bars, and gravel. Treacherous quicksand dots the bottom. Each bank is a slippery, cliff-like wall; it may be 10 feet high, or 50, except where side streams have cut a passage down to it.

Crossing such a river often was a terrific job. If the river bed was firm enough for wagons, the travelers were lucky. If it was not, they cut cottonwood branches and built a sort of mattress over the soft spots. Then they might have to let the wagons down the steep bank with ropes.

At the bottom, they tied a few wagons together, to give a hold on any that might stick in mud or quicksand, or be carried away by the strong current. Ten or twenty teams were then hitched to the chain, and away the party went, with the animals splashing and tugging, and the men pushing and prying at the wheels with poles. In times of high water, the animals had to swim across, and the wagons were unloaded and floated across.

The Gold Rush of '49 and Mining Life

Four months, six months, or even more of such travel brought the train of covered wagons to its destination in the Far West. On the way, some people had died or had been killed by Indians; babies had been born. If crimes had been committed, elected leaders had tried the criminals and fixed punishment.

When the caravans reached Oregon, they were in forest land. There the settlers cleared farms just as in the Middle West. But in 1849 movement to the West took on a new character. Gold was found in California and immediately there was a tremendous rush to reach these new riches. This led to the wild, hard life of mining camps (*see* California; Far West).

Settling on the Prairie in Sod Houses

During the years of the gold rush nobody thought of the prairie country except as an obstacle to be

crossed as quickly as possible. But after the Civil War several changes worked together to make people think of settling there. The low rates charged by the newly invented steamships had opened a vast market for American wheat and meat in Europe. Railroads were reaching west of the Missouri now, and could carry away such products. Much of the prairie land was found to be good for wheat; and where the climate was too dry for wheat, cattle could be raised. These changes brought a rush of settlers to the prairies of Kansas, Nebraska, and the Dakotas. The article Cattle tells how the beef industry grew; here let us see how other pioneers struggled to start wheat farms.

Like all pioneers, these settlers had to make homes out of any material they had. In this treeless land, the only material was sod, the top layer of prairie earth that was held together by interlaced roots of tough prairie grass. The home builder cut square chunks of sod with a spade and piled them up to make the walls of his home. For a roof he used a wooden frame covered with tar paper or old lumber. He bought good lumber for a door, if he could afford it.

To prepare the land, he needed a plow and work animals from the start to break up the tough sod. These pioneers had to clear the land rapidly in order to raise large crops of wheat and sell them so that they could buy the other necessities of life.

Since trees were scarce, they used dried buffalo droppings, called *chips*, for fuel. Early comers settled near streams, but all settlers tried to drill wells as soon as possible, to insure a water supply if the stream should run dry. Every settler also procured a windmill as soon as he could. Then the strong wind, which never ceases blowing over the open prairie, would pump the water for him.

Crop Failures and Lonely Lives

Settlers here depended from the start upon being able to sell crops. But the varying prairie weather made crop prospects a gamble every year. Some years were dry; then the crops seared in the fields, while the settlers baked in furnace heat. In other years the rains were plentiful, but a plague of grasshoppers would eat the wheat during the summer; or rust, smut, and other plant diseases would get into the crop. Good years came too; but all too often the money from good years was spent getting through the bad ones.

Another hardship was loneliness. Farther east, a man could make a living from a *quarter section*, or one-fourth of a square mile, of good land. Out here a full section was none too much. Hence the sod houses often stood several miles apart, with nothing between but waving grass or a sea of wheat. The only towns consisted of a few stores and houses clustered around a grain elevator; and these towns were miles apart along the railroads. Many settlers, especially the women, went crazy from loneliness, hardship, and despair over bleak prospects. Winter was even more trying than summer. Howling blizzards swept the land, without even a tree to break their force, and buried everything under huge snowdrifts. Often the live stock perished, because the animals could not paw down through the snow to get dried grass, and the settler did not have feed enough to last through the winter. Many a person died because no doctor could get through the snow from the nearest town.

A LONELY SOD HOUSE ON THE WESTERN PLAINS

This Nebraska sod house is typical of the homes which pioneers built while they were establishing wheat farms on the western prairie. Many such houses were miserable hovels; but this one has frame windows and good lumber to support the roof.

After years of such trials, the pluckier and more skilful settlers began to get ahead. They got windmills and machinery. In the eastern part of the prairie, the trees that had been planted made life pleasanter. The windbreaks planted west and north of the farmhouses helped to hold off snowdrifts in winter and provided shade in summer. The towns, too, had grown; and by the beginning of the 20th century, civilization was well established on the prairie.

Pioneer Settlements Become Civilized Communities

THIS CONQUEST of the prairie was the last large-scale pioneering effort made within the United States. It filled the last gap in the settlement of the country, and spread civilization in an unbroken chain from the Atlantic to the Pacific. But long before this was accomplished, two developments had brought the story of pioneer life farther east to a close. One of them was good transportation. The other was the growth of towns, where the settlers could trade and enjoy the benefits of community life.

Developing Good Transportation

In the early days east of the Mississippi, difficulties of transportation all but paralyzed trade. The only way settlers could haul crops overland to a city market was with animals. But the nearest city markets were hundreds of miles away, beyond the mountains A journey to any of them would take weeks; and animals

could not haul loads big enough to pay for weeks of time. The same long expensive haul was required to bring in manufactured goods.

Settlers along the Ohio or connecting rivers could float good-sized loads downstream to market in arks and flatboats, but they had to spend months getting home, especially if they poled a boat upstream with supplies. They, therefore, could not hope to make much progress until transportation methods improved.

To meet this need Congress in 1806 authorized construction of the National Pike, or Cumberland Road, from Maryland to the Ohio River (*see* Roads and Streets). The National Pike reached Wheeling in 1816, and in 1825 the opening of the Erie Canal gave a good connection between New York City and the Great Lakes. Meanwhile, in 1811, the first steamboat had appeared upon the Ohio River. Others followed rapidly, and provided transportation along the Ohio and Mississippi, and later on the Missouri River.

These improvements in transportation opened the way to prosperity in the Middle West. In 1825, for example, the only markets for Cincinnati flour were local townspeople and the river-steamer trade. The price was about $3.00 a barrel. In 1835 demand from eastern cities had raised the price to $6.00 a barrel. In that year, the farmer got 32 cents a bushel for corn; formerly he had been lucky to get 12 cents. The quantities sold increased in even greater proportion.

The next improvement was the railroad, which reached regions far from the lakes and larger rivers By 1850 good transportation was becoming available practically everywhere east of the Mississippi.

The pioneers west of the Mississippi had much less trouble with transportation. The first settlers on the Pacific coast had a hard time getting there; but once they had arrived, they could carry on trade with eastern markets, in sailing vessels, and they could pay for eastern goods with newly mined gold. The prairie settlers never had a bad transportation problem, because the railroads were there ahead of them.

How Towns and Cities Got Their Start

The first towns west of the Appalachian Mountains grew up around the forts which provided protection from Indians. Detroit and Pittsburgh got their start this way. Later, the great factor which determined where towns and cities would grow was transportation. Towns along the Ohio usually grew up at points where important natural trails reached the river, or where tributary rivers flowed into it. At such junctions, somebody would start a store, and someone else would open a tavern or inn, to accommodate travelers who had money to spend. Often a blacksmith's shop, and usually a mill run by water power would be established. Mills were much in demand, because the settlers could not produce satisfactory flour for themselves from wheat. As soon as possible a school and churches were added.

Towns and cities grew up similarly on the Great Lakes, at river mouths, and at trail ends. Away from the larger rivers and the Great Lakes, small inland towns got their start at fords across rivers, at branches and crossings of the main trails, or perhaps at the site of a flour mill. Whether or not they grew depended upon whether they had advantages for any activity other than service to the neighborhood.

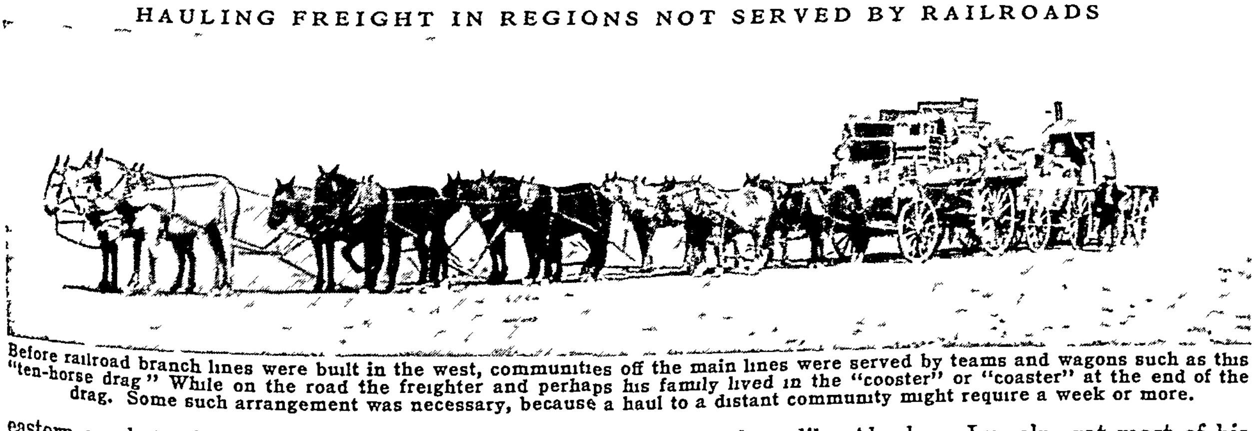
Once good transportation became available and money came into the country, some of these communities grew rapidly, because they had splendid advantages as centers for trade. When suitable raw materials were at hand, factories appeared, to compete with the East in supplying the local market. The workmen created still more trade, and enlarged the market for the farmers.

Growth of Education and Communication

In the early years of settlement east of the Mississippi, no pioneer community could afford to spend money on schools and education. Whatever the children learned was taught them by their elders. The pioneers, however, did what they could to promote learning. They held spelling contests, called "spelldowns," and cherished any books they might own. Many a boy, like Abraham Lincoln, got most of his early education from only one or two books.

After the land had been cleared and the struggle to get the necessaries became easier, the pioneers sometimes hired a schoolmaster and paid him "in kind"—that is, with his food, a home, and a tiny sum in money. The most important help, however, came from action by the national and state governments, which set aside land for the support of schools. As soon as settle-

HAULING FREIGHT IN REGIONS NOT SERVED BY RAILROADS



Before railroad branch lines were built in the west, communities off the main lines were served by teams and wagons such as this "ten-horse drag" While on the road the freighter and perhaps his family lived in the "cooster" or "coaster" at the end of the drag. Some such arrangement was necessary, because a haul to a distant community might require a week or more.

ment made the land valuable, it was sold and the money, together with taxes, provided support for free public education (*see* Education).

Communication of news and transaction of business by letter were crippled at first, not only by lack of transportation, but also because the people could not pay for such services. News traveled largely by word of mouth, and travelers were welcome everywhere, because they could tell what was happening in other parts of the world. As soon as steamboats appeared, good postal service was provided for all the communities they served. Then newspapers from the East put the settlers in touch with national and world affairs. Men also began publishing local newspapers, even before the communities could support such undertakings. Many of them did so for the same reason that lawyers rode the circuit—because the newspaper gave them power and influence in local and state politics.

Historic Problems of the Pioneers

THROUGHOUT history most pioneering efforts have consisted of three waves or phases. First, the new country was entered by explorers or exploring missionaries. Usually the explorers were followed by a mixed group of hunters, travelers, traders, and founders of mission settlements. Except for the missionaries, these men expected to stay only a short time, and then to return to civilization with whatever they had gained; but they stayed on the same ground longer than the explorers, and obtained more detailed knowledge of the region.

These two waves may be expected to enter any newly opened country almost immediately. Whether the third wave—the wave of pioneer settlers—ever will come depends largely upon conditions in the homeland. Explorers, hunters, and trappers need little incentive to plunge into the wilderness. Most of them enjoy the thrill of adventuring in new lands. But people of settled habits, like farmers, do not leave civilized surroundings unless some strong motive drives them. In the United States, this motive was largely *land hunger* —the desire to win a better living for themselves and their children, by taking up and farming new land.

Early agricultural methods had an exhausting effect on the land and many an eastern farm owner found his land producing less and less, until finally he had to abandon it. He then had to choose between starting over again as a laborer or going west into new country. Again, many families went pioneering because they disliked the restraints of civilized life. There were men who could cultivate land but who did not have the knack of trading shrewdly with buyers and merchants, and so could not get along in regions where most affairs were transacted with money.

Finally, the landseeking pioneers were always accompanied by a fringe of ne'er-do-wells, criminals, and sharpers, who expected to do well for themselves in a country where law and order were not yet established.

Problems of Land Ownership

Since desire to own land was the motive behind most American pioneering, the movement was profoundly affected by the policies of the national and state governments concerning land ownership. Fortunately, the governments encouraged settlement from the start. Also, throughout most of the 19th century, plenty of land was available; the governments therefore followed one of the most generous policies in history—providing land for all who asked for it (*see* Lands, Public). Nevertheless, many troublesome and heartbreaking problems often had to be solved before a settler's ownership was secure. Almost always the genuine settlers were preceded by a wave of *squatters*, men who occupied land without obtaining legal ownership. When the legal owner appeared, the squatter often refused to move; and in the early, lawless days, the rightful owner might have to fight for his land.

Such troubles were largely ended when the Homestead Act was passed in 1862. Thereafter, squatters could protect their interests by *making entry*, or declaring intention to acquire the land under the terms of the Act, at the time they occupied it.

Relations with the Indians

IN ADDITION TO these problems of land ownership there was the danger from hostile Indians, which haunted the pioneers from the first almost to the last. The Indians, for the most part, were friendly enough, so long as the whites were content to hunt, fish, and trap, but when the pioneers started to clear land, and thus drove away the game, there was trouble. Then the Indians fought, as any men would, to defend their lands and their source of livelihood.

This struggle began when the pioneers first entered Tennessee, Kentucky, and Ohio; and the weak national government under the Articles of Confederation could do nothing to protect them. After a new government was set up under the Constitution, it adopted an Indian policy which was to have tremendous effect, for both good and bad, upon the pioneers.

The United States assumed supreme authority over all the national territory. Under this supreme control, however, the various Indian tribes were considered separate nations, and the United States dealt with them by treaty, as it did with foreign nations. It recognized their rights to certain hunting grounds, and agreed that whites should stay out, except that they might use certain trails through the tribal land. The Natchez Road, the Michigan Road, and the Santa Fe Trail are examples of such "treaty" roads.

Broken Treaties, Frauds, and Wars

In this way, the government tried to deal fairly with the Indians; and throughout the 19th century, it took land from them only by treaty, with payment in money and supplies. As a rule, the Indians were willing to keep their agreements, and rarely took to the warpath unless they felt they had been wronged. Most

Indian wars started because the government could not, or did not, compel the traders and pioneers to observe the treaties and deal honestly with the Indians.

The traders were the worst offenders. They sold Indians whisky, in defiance of the law. They sold other goods on credit at extravagant prices, and when the Indians brought in furs, the traders cheated in their accounts, so the Indians remained always in debt. When trouble followed, the whites would call for troops, and the Indians would be the losers. They had to surrender their hunting lands and move west of a new dividing line, before the government would agree to pay their debts. Thus they were gradually pushed off their ancestral lands. The entire Northwest Territory was cleared of Indians in this way; the last of them who occupied good farm land were packed off to the West after the Black Hawk War in 1832 (*see* Indians).

Andrew Jackson's Indian Policy

The tribes in the South, however, were too highly civilized and too intelligent to be thus victimized. During the presidency of Andrew Jackson, a brilliant new plan was devised for settling the Indian problem once and for all. West of the Missouri River lay the vast prairies which the white men believed they would never want. Here the Indians could live as they liked. The Cherokees, the most highly civilized nation, and other tribes were told, therefore, that the government would give them prairie land, and they must move to it.

The Indians protested that this was a plain violation of their treaty rights. But after years of bickering and threats of war, they were moved to their new lands in 1839 and 1840. This was the beginning of the Indian Territory, which is now part of Oklahoma.

For many years, this policy proved fairly successful. The whites complained constantly of the Indians' stealing; local fights occurred from time to time; but the Indians did not make a desperate last stand until railroads began to penetrate the prairies.

Indian Troubles in the West

Then the old story repeated itself. White hunters, such as Buffalo Bill, began to slaughter the bison wholesale, to provide meat for the construction camps; settlements and towns sprang up; white traders, gold seekers, and even settlers, poured into Indian lands. Years of savage warfare followed, until finally the government concentrated all the Indians on reservations, and the entire continent was open for white settlement. During all this century of trouble, the principal sufferers, of course, were the Indians and the settlers on isolated farms, for the traders, railroad builders, and townspeople usually had protection from the army. But the courage of the pioneers pulled them through this trial, as it did through all others; and so they completed their historic task.

Pioneering in Modern Times

While the American pioneers were spreading farms and ranches over the country, the Dutch were pioneering in South Africa. British settlers were moving into the interior of Canada and Australia, and frontier communities were spreading in South America, especially in Argentina, Uruguay, and Paraguay.

In most of these regions pioneering is over, because today's settlers have every advantage of civilization at their command. But elsewhere pioneering continues, and the pioneering spirit lives on. One of the most astonishing pioneer movements of modern times is the Soviet government's development of the bleak arctic regions of Russia and Siberia. Today Canada, too, still has a pioneer fringe, in the Peace River country of the far Northwest. In many parts of Alaska, settlers are clearing land and establishing new homes. Most modern pioneers, however, are not homeseekers.

All over the world, for example, highly trained scientists and skilled explorers are searching wild lands for petroleum and other minerals. Other pioneers in science plunge into tropical wildernesses to study yellow fever and similar diseases; and many of them have died at their work. There are also pioneers of the air—fliers who have blazed the way for airplane travel by trying out new airplanes and new routes. And there are pioneers in business—men who try out new ideas and new services and enrich life for us all. Thus has most pioneering shifted its objectives from the settling of new land. But as long as there are men who thrill to the call of the new and the unknown, we shall have pioneering, whatever the objectives they seek.

EARLY CIVILIZATION IN THE WEST

For many years, such drab little towns as this were the western pioneer's only contact with civilized community life. A common device to make shacks look larger was a "false-front" second story.

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Pirates and Piracy. Stories of pirates and buried treasure, of the "Jolly Roger," the black flag with the skull and cross-bones, of captains and crews "walking the plank," while the cut-throats of the Spanish Main sang lusty deep-sea songs to the rhythm of waving cutlasses—such tales have been read and re-read by English and American children for generations. They usually end with the pirate chief hanging at the end of a ship's yard-arm, after his black band has been sent to "Davy Jones's locker" in a hot fight with a man-o'-war.

In these tales there is at once more and less than the truth. When history's microscope is turned on the pirate, he usually turns out to be a dismal villain without a trace of romance. He played on the high seas the same part that the bully leader of a sneaking band of thieves and murderers plays on land. On the other hand, pirates were by no means always punished or even discouraged in their lawless employment. Men of position and wealth at times provided them with ships and equipment in return for a share of the booty. Even governments sometimes gave secret support to adventurers whom we should regard as pirates, provided they attacked only enemy or neutral vessels.

The Rivalry of the Seas

To understand this attitude, one must realize the intense rivalry that existed on the seas during the 16th, 17th, and 18th centuries. Even when peace reigned on land, the ships of England, Spain, Holland, France, and Portugal continually struggled and fought to get the upper hand in the commerce with the West and East Indies and America. The assistance of rogue sea captains was not scorned in the contest, and it was an easy step for these shipmasters to turn from patriotic fighting to private buccaneering.

Piracy has existed since the earliest days of seafaring. From the times described in Homer's 'Odyssey' to the present days of occasional Malay raids in the China seas, the ocean has been looked upon by lawless men as a sort of watery "no man's land." In the earlier days, piracy was almost respectable, but when the great nations of Europe began to depend on their foreign commerce, international law declared it a crime against all mankind. Death was the usual penalty when caught. But despite severe measures to repress them, pirates continued to flourish so long as they could find a place of refuge and a market for their stolen goods.

Decatur and the Pirates

The last great den of what may be called "pirates" on the Barbary coast of northern Africa was attacked by Stephen Decatur in command of a United States fleet in 1815, and their power was broken (*see* Decatur). These Barbary corsairs, as they were called, had been protected for centuries by the native rulers of these wild shores. Organized piracy today has been wiped out everywhere except on the coast and rivers of China, where pirate bands in sailing junks still plunder small craft when opportunity offers.

Among the best-known pirates, besides Captain Kidd (*see* Kidd, Captain William), was Captain Avery, who was put to death in 1696. His adventures are said to have inspired Defoe's 'Life, Adventure, and Piracies of Captain Singleton'. Another famous freebooter was Bartholemew Roberts, the nearest approach in history to the pirate of romance. He was killed in battle off the coast of Africa in 1722.

Treasure hunters still dig along the coast of North Carolina seeking the loot supposed to have been buried by the notorious Capt. Edward Teach or Thatch, better known as "Blackbeard" because of his great black beard. Teach was killed in 1718 in a hand-to-hand battle with naval men from Virginia. Teach, an Englishman, had been a privateer in the War of Spanish Succession (1701–13).

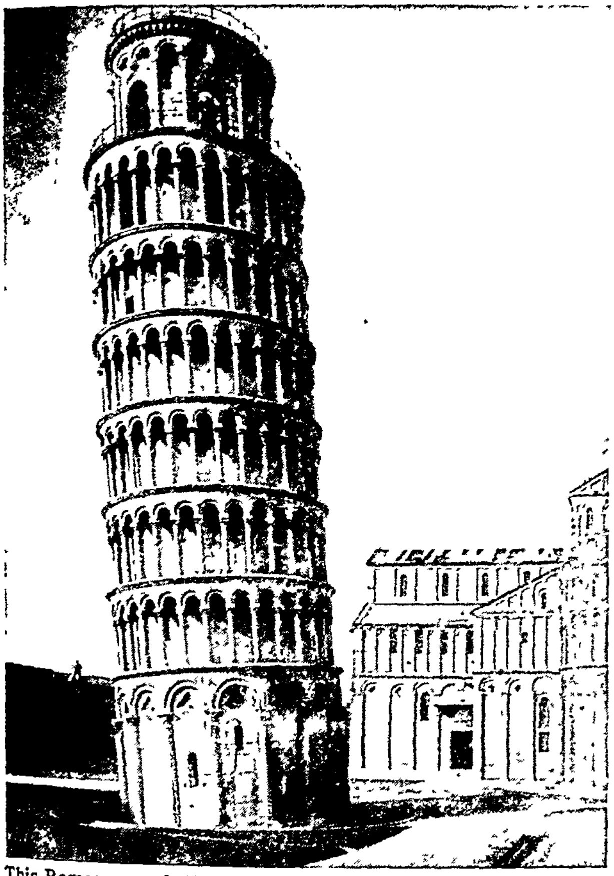
No civilized nation ever recognized pirates, but "privateers," ships owned and operated by private citizens with commissions known as "letters of marque," were for centuries assigned to attack merchant ships or even war vessels of an enemy. Their reward was the vessels and merchandise they captured. Privateering was abolished in Europe in 1856 by the Declaration of Paris. The United States, whose privateers had been so successful in the War of 1812, refused to sign, but did abandon the practise. Among the most famous of privateers was Sir Francis Drake (*see* Drake, Sir Francis).

Pisa (*pē'zä*), **Italy.** The "leaning tower" of Pisa has done more to make this city on the Arno famous than all its stirring history, its noted paintings, and its other great buildings. Constructed entirely of white marble, with walls 13 feet thick at the base, the eight-storied tower rises 179 feet, about the height of a 15-story building. At the top it is 16½ feet out of the perpendicular; in other words, a stone dropped from the lower side of the upper gallery would strike the ground 16½ feet from the wall at the bottom of the tower.

A stairway of 300 steps built in the walls leads to the top, where a magnificent view of the city and of the sea, six miles away, is unfolded. The tower, intended as a bell-tower for the nearby cathedral, was begun in 1174 and finished in 1350. The foundations were laid in sand and it started to tip after the first three galleries had been built, but the work went on with slightly changed plans. Some engineers refer to it as the "falling tower" of Pisa, for it has tipped an additional foot in the last century. Galileo, who was born in Pisa, is said to have used the tower in experiments to determine the velocity of falling bodies (*see* Galileo). In the same square as the tower are the famous Pisa cathedral and baptistery, which like the tower are fine examples of Romanesque architecture. During the second World War when Pisa suffered heavy damage from air raids and artillery fire, these structures were damaged, but not beyond repair.

Pisa was a Roman colony but did not gain great historical importance until the depredations of the Saracens in the 11th century. The inhabitants not

THE LEANING TOWER OF PISA



This Romanesque bell tower of the Cathedral of Pisa continues to tip to one side. It was begun in the 12th century, and one side started to sink in the sand before the tower was completed. A wing of the cathedral is shown in the background.

only drove out these foes, but pursued them to Sicily and even to the shores of Africa. Pisa long remained a powerful and wealthy maritime city republic. For four centuries it took an active part in the wars and politics of Italy. At the height of its power in the 12th century, it had a population of 150,000 and a territory that stretched along the coast from near Genoa almost to Rome. It ruled over Corsica, Sardinia, and the Balearic Islands.

Pisa began to decline when the Genoese defeated its fleet in the great sea battle off Meloria (near Leghorn) in 1284. In 1406 Florence conquered the city and held it in subjection except for the years between 1494 and 1509. A great church council was called in the city in 1409 to settle rival claims to the papacy. As a part of the grand duchy of Tuscany, Pisa was absorbed into the kingdom of Italy in 1859.

Pisa now has little commercial importance. Cotton manufacture is the chief industry. The university, founded 1343, is still a noted center of learning. Population (1951 census, preliminary), 75,851, including suburbs.

PITCHER, MOLLY (1754–1832). The great heroine of the Revolutionary War battle of Monmouth was sturdy, talkative Molly Pitcher. (Her real name was Mary Ludwig Hays.) On June 28, 1778, American troops waited on a sun-blazed field for British and Hessian soldiers to attack. One of the American soldiers was Molly's husband, John Hays, a member of an artillery unit.

Molly had come from her father's farm to visit her husband. When the battle began she stayed and helped. Under the torrid sun she carried water from a well to the hot, exhausted, and crying wounded men. When the soldiers saw her they would shout, "Here comes Molly with the pitcher!" Soon this welcoming call was shortened to "Molly Pitcher!"

On one trip she reached her husband's cannon just as he fell, overcome by a wound and the heat. Molly took his place. She swabbed out the hot cannon, drove the charge and ball down the barrel, and stepped aside as the gun blasted its iron at the British and Hessians. Legend has it that General Washington rewarded her heroism by making her a sergeant.

Molly, the daughter of John Ludwig, was born on a dairy farm between Trenton and Princeton, N. J., on Oct. 13, 1754. She was christened Mary. Molly was a strong child and helped in the fields and barn. It is told that she could swing a three-bushel sack of wheat (180 pounds) to her shoulder. When she was about 15 she was taken to Carlisle, Pa., as a servant in the home of Dr. William Irvine. That same year she married John Caspar Hays, a barber with a shop near the Irvines. At the start of the Revolution, John enlisted. Molly left the Irvines to visit with her family and to be near her husband.

After the war she and her husband returned to Carlisle. John died a few years later. Molly went on with her daily tasks of scrubbing, ironing, cleaning, and caring for other people's children. She was brusque but kindly. Some years later she married George McCauley. In 1822 the state of Pennsylvania voted her a sum of $40 and a like amount every six months for the rest of her life, as a reward for her heroic service. She died on Jan. 22, 1832, at the age of 77. On a monument raised in 1878 at Freehold, N. J., to commemorate the battle of Monmouth, Molly is shown performing her heroic rôle.

MOLLY PITCHER CHARGES HER CANNON

The Revolutionary War heroine took her husband's place at the battle of Monmouth when he fell exhausted and wounded. The painting is by C. Y. Turner.

PITCHER PLANTS. Some plants trap and digest insects in order to supply themselves with nitrogenous food. The pitcher plant is the best known of these.

Many species grow in tropical Asia and Borneo. They climb up on shrubs by means of a tendril that extends from the midrib to beyond the tip of the leaf. Little pitchers with open lids rise from many of the tendrils. These are the traps.

From the inward curving rim of the pitcher, glands exude a sweet juice attractive to insects. Insects are attracted also by the red-colored rim and cover. The nectar may be an intoxicant, since many usually wary insects are trapped. The inside of the pitcher is smooth. Once over the rim the insect cannot halt its slide. Glands in the bottom partly fill the pitcher with a digestive fluid. The insects are drowned and decomposed in this fluid.

American pitcher plants, often called "sidesaddle" plants, grow in swampy places. The leaves form a circle about the root. Each leaf is a pitcher. Its color is green, blotched with purple; the flattened lid and the mouth are more brightly colored. On the inner side of the pitcher is a wing or "seam" that joins the edges of the leaf to form the pitcher. The wing, the rim, and the underside of the lid have glands that secrete nectar. Thus an insect is attracted up the side and over the edge into the trap. The inside of the pitcher is smooth and has downward-pointing hairs that prevent the insect from re-ascending. The victim drowns and is digested in the fluid at the bottom of the pitcher. Just how the plant digests and absorbs the insects is not known. A huge California plant has pitchers three feet high.

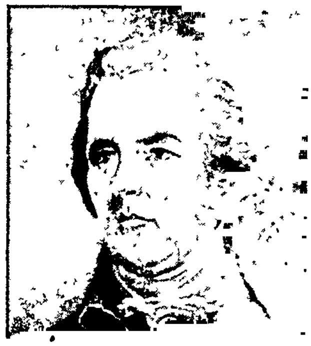
The sidesaddle plants belong to the genus *Sarracenia;* those with the pitcher at the tip of the tendrils belong to the genus *Nepenthes.* (For a picture, *see* Plant Life. *See also* Sundew; Venus's-Flytrap.)

PITT, WILLIAM, THE YOUNGER (1759–1806). When he was only 24 years old, William Pitt became prime minister of England. He was the youngest man ever to hold that high office. For 17 uninterrupted years (1783–1801), and for two more (1804–6), he ably led England through troubles brought on by the French Revolution and the rise of Napoleon. He strengthened the nation's credit, increased its commerce, and aided the beginning of the Industrial Revolution.

His father was William Pitt, Earl of Chatham (*see* Chatham). Historians distinguish the two as "the Elder" and "the Younger." The younger William was a second son. He was born at Hayes, in Kent, on May 28, 1759. A sickly child, he was tutored at home. He entered Cambridge University when he was 14, and after winning his master of arts degree he studied law. The elder Pitt had been a great prime minister and the son was drawn to politics. In 1780 he was elected to the House of Commons from a pocket borough (*see* Parliament). His first speech, on economic reform, compared favorably with his father's brilliant speeches before Parliament.

Pitt became prime minister in 1783. He set about making financial and other reforms. He wanted to abolish the slave trade, and he avoided taxes that might have hampered the Industrial Revolution. In 1793 war with France became unavoidable. Pitt formed European alliances against the French.

WILLIAM PITT



This portrait of the English statesman is by John Hoppner.

In 1801 King George III refused to support his measures to solve the Irish problem, and Pitt resigned. After two years he was called back to lead the nation against Napoleon's mounting power. Ill and worn out by his labors, Pitt died on Jan. 23, 1806.

Pitt was aloof and sarcastic with most people, but he was gay with his friends. Pitt was nervous and often in ill health. He never married. A poor manager of his own affairs, Pitt went deeply into debt. Nevertheless he twice refused huge money gifts offered by London merchants and the king. After his death his nation, grateful for his services, paid his debts and buried him in Westminster Abbey.

PITTSBURGH, PA. In its early days Pittsburgh was the "gateway of the west" for Indian traders and pioneers. A site at the hub of river and land transport amid a bountiful supply of coal and other raw materials made it grow from a collection of a few huts to one of the world's great industrial centers.

Pittsburgh lies on and near a point of land formed by the meeting of the Allegheny River from the north and the Monongahela River from the south. Just before joining to form the Ohio, the rivers flow in a general westerly direction, and from the junction the Ohio flows for a few miles in a northwesterly direction. The city's business district extends back from the "Point" and is called the "Golden Triangle." The city as a whole stretches westward along both banks of the Ohio, eastward over the rises in back of the Golden Triangle, and northward and southward from the banks of the Allegheny and the Monongahela.

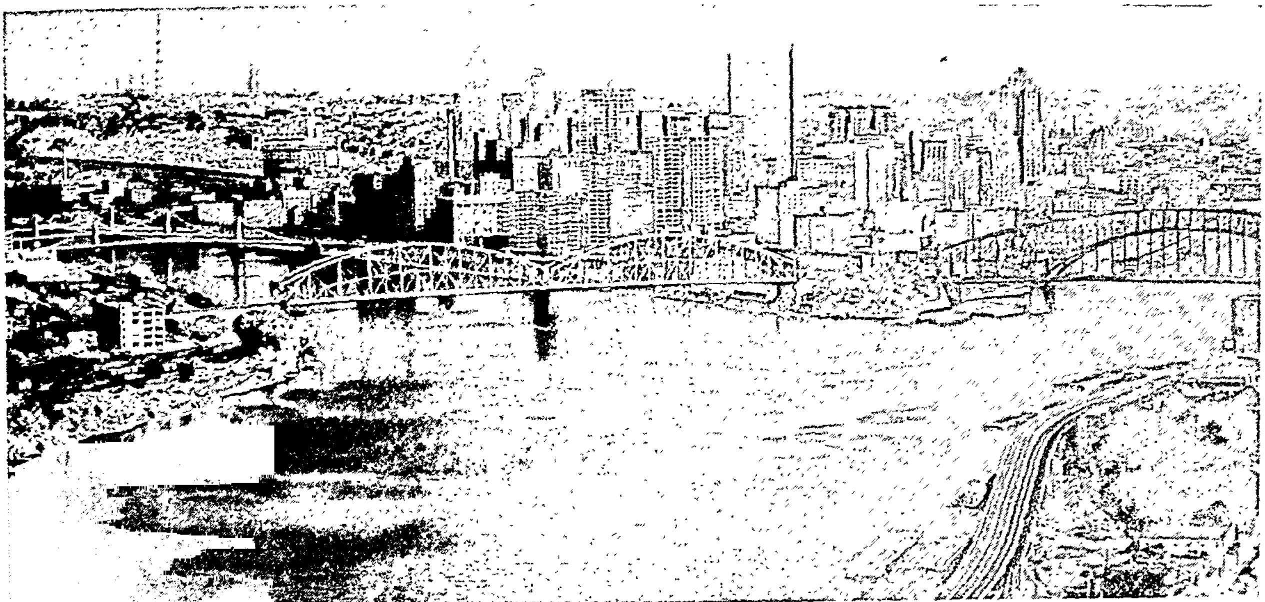
Some of the city's hills rise steeply. From the southern bank of the Monongahela Mount Washington rears almost perpendicularly. To this steep slope cling the tracks of Pittsburgh's "incline railway," and piercing it are the great twin tubes of Liberty Tunnel, leading to the suburban "South Hills" district.

Pittsburgh's industrial plants hug the river banks, served by both water and rail transport. Numerous bridges cross the rivers to city areas north and south of the rivers.

Pittsburgh's Industries

Because it is a principal steel producing region, Pittsburgh is called the "Steel City." Great beds of coal underlie it and the surrounding area. Plants make coal into coke, heating and illuminating gas, and chemical by-products. Most of the iron

PITTSBURGH AT THE "POINT"



Here is where the Allegheny from the left and the Monongahela from the right join to form the great Ohio River. The "Point" lies between the two, and behind this rise the tall towers of Pittsburgh's Golden Triangle. Pittsburgh has many bridges over ravines and rivers. The two crossing the mouths of the Allegheny and the Monongahela are called the "point bridges."

ore used in Pittsburgh's blast furnaces is shipped on Great Lakes steamers from deposits in Minnesota and Upper Michigan. The harbor of Erie, Pa., receives most of the ore and ships it on to Pittsburgh by rail.

Near Pittsburgh are beds of silica sand suitable for making plate glass, bottles, and other glass articles. Alumina clay and other clays used for making firebricks (refractories) for steel and glass furnaces are found nearby too. The city produces much aluminum and is the headquarters for the largest aluminum-producing company in America. Its refineries process petroleum. Various industries manufacture more than 5,000 different articles, including rolling-mill machinery; gasoline pumps; other iron and steel goods; aluminum, brass, copper, and tin articles; railroad air brakes; electrical motors and equipment; and linoleum and other articles using cork.

Points of Interest

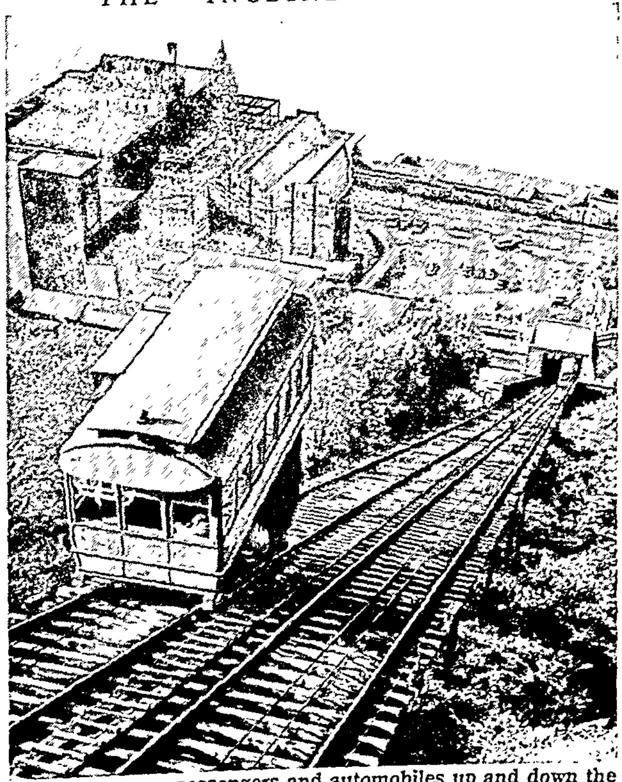
A number of blocks east of the Golden Triangle is the University of Pittsburgh, which grew from Pittsburgh Academy (established 1787). The main structure is the towering 42-story "Cathedral of Learning," which houses administrative offices, classrooms, laboratories, and libraries. Most of the university buildings are of Gothic design. On the campus is the Stephen Collins Foster Memorial Building (*see* Foster). This contains a music hall and a little theater.

Schenley Park, more than 300 acres in area, lies east of the university. Phipps Conservatory in the park displays thousands of flowers and plants in natural settings. The Carnegie Institute of Technology lies in the northern part of the park. It was endowed by Andrew Carnegie in 1905 (*see* Carnegie). Its specialized schools instruct in engineering, the fine arts, graphic arts, the theater, and library science.

In this area is the Mellon Institute for Industrial Research. Close by is the Carnegie Institute, the great building containing a library, museum, art gallery, and music hall. Each year the institute holds the famous Carnegie International Art Show.

Other Pittsburgh institutions of higher learning include Duquesne University, Mount Mercy College (for women), and the Pennsylvania College for Women. Large parks in the city include Frick Park and

THE "INCLINE RAILWAY"



These cars carry passengers and automobiles up and down the steep slope of Mount Washington. Beyond the bank at the bottom flows the Monongahela River.

Highland Park, with its zoo. North of the Allegheny are the Allegheny Observatory and Buhl Planetarium.

Pittsburgh's Beginning

By 1750 the strategic importance of Pittsburgh's site was apparent to both the French in Canada and to the English in Virginia. The Ohio led to the rich lands of the Ohio Valley and, through the Mississippi, to those of the Mississippi Valley. By portaging, the French could reach the Pittsburgh site from Lake Erie by way of the Allegheny. The Virginians and Pennsylvanians could reach it by overland travel or by descending the current of the Monongahela.

In 1753 when George Washington, then a young Virginia militia major, surveyed the scene from Mount Washington, it held an Indian trading post and a few settlers. Washington reported of the site: "... I think [it] extremely well situated for a Fort. . . ."

The French had already reached this conclusion. They drove the English out of Kentucky, Ohio, and western Pennsylvania. In 1754 English soldiers building a fort at the Point were driven away by the French. The French then built Fort Duquesne there. Washington, with a few hundred men, met the retreating English and took them under his command. He built Fort Necessity not far from the present West Virginia-Pennsylvania border. The French attacked Fort Necessity, and Washington was forced to surrender. Thus began the French and Indian War that ended with the victorious English acquiring all Canada. (*See* French and Indian War; Washington, George.)

Before the English victory in Canada, General Braddock was fatally wounded and his army defeated by the French on Braddock's Field near the Point. In 1758, after the hard-pressed French had burned and deserted Fort Duquesne, the English occupied the site. The next year they began building Fort Pitt.

Fort Pitt withstood a two-month Indian siege in the Pontiac War of 1763. A brick blockhouse built within the fort's walls in 1764 is preserved in modern Pittsburgh. Pittsburgh remained a garrison town until after the War of 1812, but it was so little threatened that the stone and brick of the fort were taken for other buildings.

The Rise of Pittsburgh

A flood of emigrants helped Pittsburgh grow. Goods from the East came to the frontier post, first by pack train, then by wagon, then over a system of canals and roads, and finally by railroad. Little industries filled emigrant needs for axes, saws, nails, shovels, knives, calico, shoes, harness, and window glass. Rafts and keel boats floated Pittsburgh goods down the Ohio, and some down the Mississippi to New Orleans. The logs of the rafts, when they reached their destinations, were taken apart and sold to be sawed into lumber, but the keel boats were loaded with cotton and sugar and poled back to Pittsburgh.

The first steamboat west of the Alleghenies was launched at Pittsburgh in 1811. Boats and steam engines became important new products. The War of 1812 spurred Pittsburgh's growth. Until the city's first successful blast furnace produced iron in 1859, it had obtained its pig iron from furnaces located near Pennsylvania and Virginia ore supplies.

When ore from the deposits around Lake Superior became available, Pittsburgh's iron and steel industry grew to giant size. The city made a large part of the Union's Civil War armaments. After the war the rapidly expanding railroads kept the furnaces burning night and day. The city's mills threw off a pall of smoke. The mixture of smoke and low-hanging clouds is called "smog," and Pittsburgh was popularly called the "Smoky City."

Leaders of Pittsburgh's great industry included such men as Andrew Carnegie, his brother Thomas, Capt. William R. Jones, Benjamin F. Jones, James Laughlin, and Henry C. Phipps. Henry C. Frick became a millionaire coal baron before he entered the steel business. The Mellon family financed many industries, including coal and aluminum.

Modern Pittsburgh

Smoke abatement was urged, and industrial plants were forced by law to install smoke burners on their chimneys. Smoke burners were too costly, however, for householders, most of whom burned soft coal. After the second World War Pittsburgh set about modernizing itself. Home use of smokeless gas and oil fuels was encouraged. More stringent laws on smoke control were passed. Several great new buildings were erected in the Golden Triangle. The land at the Point was made into a park.

The area of early Pittsburgh took in little more than the Golden Triangle. It was incorporated as a borough in 1794 and as a city in 1816. In 1867 the boundaries were extended to take in settled land to the east, in 1872 to take in the south bank of the Monongahela, and in 1907 to take in the city of Allegheny, on the north bank of the Allegheny and Ohio rivers. Later expansion has taken in other areas, but many parts of metropolitan Pittsburgh remain politically independent of the city. Pittsburgh's government is the mayor-council form. Population (1950 census), 676,806.

PIUS, POPES. Twelve popes have borne the name Pius. The earliest (PIUS I, 140–154?) belonged to the period before Christianity was a tolerated religion. The latest was elected to the papal throne in 1939.

PIUS II, who was pope from 1458 to 1464, was a famous "humanist" scholar and writer of the Renaissance, named Aeneas Sylvius Piccolomini. He was born at Siena and won his cardinalate by his services in bringing Germany back to Roman obedience, after the schismatic Council of Basel (1431–49) and its antipope Felix V. As pope he continued the patronage of learning and art begun by Nicholas V, 1447–55; but his chief interest was in arousing Europe to a crusade against the Turks who had taken Constantinople in 1453. He died at Ancona, Italy, waiting for the fleet and armies which he vainly hoped would rally at his call. His letters and other literary works are important sources for the history of the time. PIUS III, who was pope for less than a year (in 1503), was a nephew of Pius II.

PIUS IV, 1559–1565, and Pius V, 1566–1572, were both active in furthering the work of the Council of Trent and in checking the spread of Protestantism. PIUS VI, 1775–1799, and PIUS VII, 1800–1823, belonged to the period of the upheaval caused by the French Revolution and Napoleon Bonaparte. PIUS VIII, 1829–1830, lived too short a time after his election to accomplish anything.

The Doctrine of Infallibility

PIUS IX, 1846–1878, was perhaps the most memorable pope of this name, alike because of his long pontificate, his early liberalism in politics (until checked by Mazzini's attempt to establish a republic in Rome, in 1849), the stern reaction in the papal government which followed under Cardinal Antonelli, and the loss of the temporal power of the papacy in 1870, when Rome was by force made the capital of the new kingdom of Italy. Pius IX thereupon established the policy by which the pope confined himself to the Vatican Palace and its surroundings, and refused recognition to the Italian king. In 1854 Pius IX issued a bull establishing as a doctrine of the church the dogma of the Immaculate Conception of the Virgin Mary. The Vatican Council, held by him in 1869–70, further proclaimed as a necessary part of the Catholic faith the doctrine of the pope's infallibility when acting officially on matters of faith and morals.

PIUS X, 1903–1914, was born to a family of limited means, his father being a postman near Venice. He became a priest at the age of 23, rose to be bishop of Mantua, was made a cardinal in 1893, and soon after became Patriarch (archbishop) of Venice. His schools and his work for missions and religious societies made him known throughout Italy. His rule as pontiff was marked by his abolition of the veto of Austria, France, and Spain on the election of the pope; and by his stanch advocacy of the Gregorian chant and opposition to secular music in the services of the church. In his pontificate came the laws in France decreeing the complete separation of church and state. In the first World War, Pius X issued on Aug. 19, 1914, a futile plea for peace. The next day he died. In 1951 he was beatified and in 1954 canonized—the 78th pope to be made a saint.

PIUS XI, 1922–1939, won the most notable triumph in the modern history of the church, for he regained the temporal power of the papacy. This power, which symbolized the independence of the church, had been lost since 1870, when Italy had seized the Papal States (*see* Papacy). Early in his pontificate, Pius XI opened the way for settling the dispute, called the "Roman Question," between Italy and the Vatican. In accord with his belief that the church had no place in party politics, he dissolved the Catholic party in Italy—as he was to do later in Mexico and France. He thus won the good will of Premier Mussolini, who then in 1925 began negotiations with the Vatican. On Feb. 11, 1929, the Lateran Treaty was signed. This treaty made the pope a sovereign ruler and Vatican City an independent state. The papal realm, comprising some 109 acres, became the smallest free nation in the world. As compensation for the territory seized in 1870, Italy paid 1,750,000 lira.

In the following years, Pius XI won world-wide fame as an advocate of peace. He insisted that world peace depended on the ideals of Christianity. He therefore stood firmly against any form of government that repressed religion. This policy gave him an active part in world affairs, for after the first World War religion became a political issue in many nations, especially Mexico, Russia, Germany, and Spain. By radio broadcasts and encyclicals, the pope rebuked the states that showed religious intolerance. He denounced also the persecution of Jews and other minority peoples, calling upon all rulers to respect the "natural rights of man." For his tireless pleas for tolerance and international good will, he became known as the "Pope of Peace."

PIUS XI
Called "Pope of Peace"

With equal vigor he faced the social problems that arose from the unrest after the first World War. He declared that widespread unemployment showed a need for economic reform, with industry recognizing the rights of workers. He also urged workers to rid themselves of envy and to cooperate with industry. Other encyclicals championed the need for Christian education and for self-discipline in young people. His encyclical on motion pictures led Catholics in the United States to form a "Legion of Decency" to boycott films considered immoral.

During the reign of Pius XI, the Catholic church grew remarkably despite the oppression of religion in many quarters. Reorganizing the missions, which had been sharply disrupted by the war, he broadened the scope of missionary work. Membership in the Roman Catholic church is estimated to have soared from about 280,000,000 to some 330,000,000.

Until his rise to the papacy, the life of Pius XI was unusually tranquil. His name was Ambrogio Damiano Achille Ratti, and he was born at Desio, near Milan, May 31, 1857. He was schooled largely by his father, director of a silk factory. When only ten years of age, the boy began his studies for the priesthood. He was ordained in 1879. After a few years of seminary teaching, he was appointed prefect of the Ambrosian Library in Milan. In 1914 he was called to Rome to take charge of the Vatican Library. His hobby was mountain climbing and he became a famous Alpinist. In 1918 he was sent to war-torn Poland to protect the church against the inroads of bolshevism. For his executive ability, he was made cardinal in 1921. Less than eight months later, he was elected pope to succeed Benedict XV.

Pius XII (Eugenio Pacelli) was elected pope on Mar. 2, 1939, his 63rd birthday, to succeed Pius XI. The new pope, who had been papal secretary of state, chose the name Pius out of respect and affection for his predecessor. His coronation took place March 12.

The election of Pius XII was unusual in many ways. He was the first papal secretary to succeed to the papacy in modern times. His election was the swiftest in history, for he was chosen by the electoral conclave on the first day of voting after only three ballots. He was the first native of Rome to be elevated to the papacy in more than 200 years, and the first pope who had visited the United States.

Born in Rome Mar. 2, 1876, Eugenio Pacelli (*pä-chĕl'lĭ*) was a member of a patrician family which held the titles of Nobles of Acquapendente and of Sant' Angelo in Vado. For two centuries the family had served the papacy, and Eugenio Pacelli's father was a lawyer for the Vatican. The boy was also expected to study law, but he determined to become a priest. After graduating from Gregorian University in Rome, he was ordained in 1899. In 1901 Pope Leo XIII assigned him to the Secretariat of State. His service there, under four successive popes, gave him an insight into European affairs which was to make him a distinguished statesman.

FUTURE POPE VISITS AMERICA

Three years before he became pope, Cardinal Pacelli visited the United States. We see him here at the left receiving an honorary degree from the Rev. John F. O'Hara, president of Notre Dame University.

In 1917 he was consecrated titular archbishop of Sardi and sent to Germany as papal nuncio by Pope Benedict XV, who was trying to halt the first World War. After the war Archbishop Pacelli remained in Germany through the troubled era of the republic.

The cardinal's hat was conferred upon him by Pope Pius XI in 1929, and a year later Cardinal Pacelli was appointed papal secretary of state. In this office he negotiated several important concordats, notably one with Adolf Hitler's new National Socialist government in 1933. As social and political unrest spread, the cardinal became noted for his stand against efforts of dictator governments to repress the church. He declared in 1935 that the church would always oppose "enemies who were possessed by superstitions of race or blood."

When he became pope in 1939 his first papal address was a plea for world peace. In October 1939, after the outbreak of the second World War, he sent out his first encyclical condemning theories of racial supremacy and the doctrines of totalitarian governments. In November, his second encyclical deplored the growth of materialism, pleaded for a "living wage" for workers, and defended their right to organize.

Pius XII repeatedly declared that he, as spiritual leader of all Catholics, could favor no one nation; but, with all his moral force, he must decry the aggressions of nations upon their neighbors. In his efforts to establish permanent peace, he consulted with Franklin D. Roosevelt's personal representative at the Vatican and with diplomats from many countries.

In 1939 Pius XII proposed a peace plan which stressed the right of all nations to life and independence, and a strict adherence to justice and charity in international undertakings. Again, in 1943, the Pope urged a world peace rooted in individual and family rights, the rights of labor, and state policies based on Christian principles. In 1944 he called for a world society with an international organization to ward off future aggressions.

After Italy entered the war in 1940 the Vatican shut its gates as neutral territory, but the papal radio kept Pius XII in touch with world leaders. Under his direction the Vatican provided aid for war victims and war prisoners throughout the world. When air raids in 1943–44 brought casualties and damage in the Vatican City area, Pius XII protested this bombing of neutral territory. After the Germans gained control of Rome in 1943 he appealed successfully to all belligerents to spare the Eternal City from devastation.

After the war Pius XII led the church in a fight against the spread of Communism. He announced in 1948 that Italians who voted for Communists would be excommunicated. In 1951 he proclaimed the dogma of the bodily assumption of the Virgin Mary.

PIZARRO (*pĭ-zär'ō*), **FRANCISCO** (about 1471–1541). The story of the conquest of Peru by an obscure adventurer forms one of the most dramatic episodes in the history of the New World. At the age of 50 Pizarro was a captain of infantry on the Isthmus of Panama, with nothing to show for years of toil and peril but a small holding of land. In little more than a decade he had conquered the fabulously wealthy empire of the Incas, and had bestowed on Spain the richest of her possessions in the Americas. Violence and perfidy were the instruments with which he worked, and by violence and perfidy he came to his death. Resolute and daring to the last degree, he was infinitely greedy and merciless, and the sufferings

POPE PIUS XII

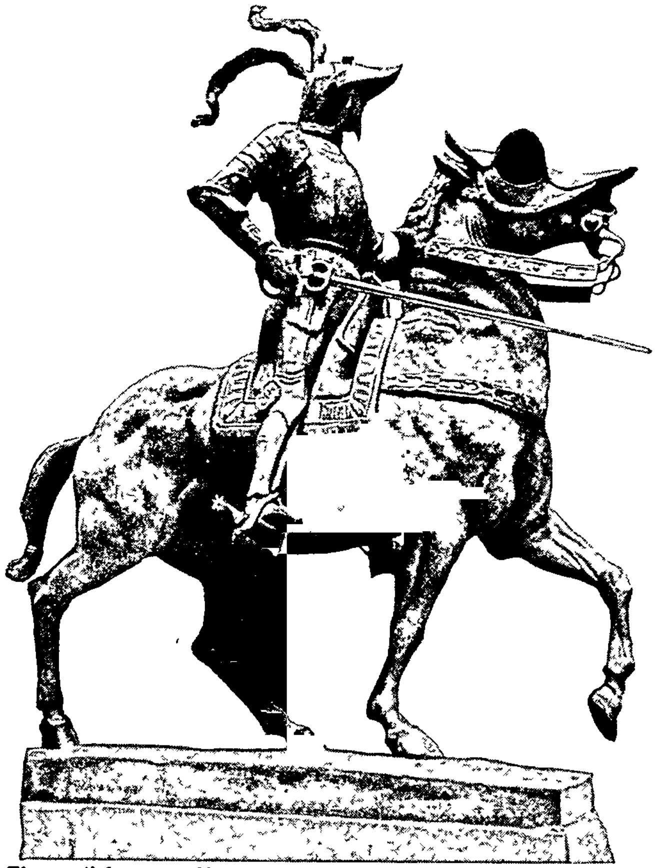
of the peaceful natives of Peru at his hands are one of the saddest chapters in history.

In extenuation of Pizarro's crimes it must be remembered that his early days were cast in dark places. He was the illegitimate son of a Spanish colonel, and was left to grow up without care. To the end of his days he was never able to write his name, and tradition says that his youth was spent as a swineherd. Some time before 1510 he sailed to seek his fortune in the recently discovered New World. After accompanying Balboa in the journey that resulted in the discovery of the Pacific Ocean (1513), he became a cattle farmer. Then reports reached him of a vast and wealthy empire to the south. Pizarro's imagination was kindled and he sought the aid of two friends in equipping an expedition for its conquest. His associates were another soldier named Diego de Almagro, who was to equip the expedition, and the vicar of Panama, Hernando de Luque, who was to furnish the funds. The three men entered into a famous written agreement, dividing equally the spoils of the empire they hoped to master. A first expedition resulted in disaster, after two years of suffering and hardship. A second expedition in 1526 fared little better. The adventurers found they were too few for the task, and Almagro was sent back to Panama for reinforcements, while Pizarro and part of the force remained on an island. But the governor of Panama was not inclined to support the enterprise, and sent vessels to bring back Pizarro and his men. Pizarro refused to return, and, drawing a line on the sand, called upon all the men who wished to remain and share in his enterprise to come over to his side. Thirteen men crossed the line, but the others returned. Soon after this the governor was induced to send one vessel to Pizarro, with which he explored the coast of Peru and collected information concerning the empire of the Incas.

Discouraged at the indifference of the governor, Pizarro returned and sailed to Spain, where he applied for authority to undertake the conquest of Peru. A commission was given him for his enterprise, and he sailed from Spain on Jan. 19, 1530, and from Panama the following year, with 3 vessels, containing fewer than 200 men and about 40 horses.

After seven years of hardship and disappointment the adventurers were now embarked on the actual conquest of Peru. After a year spent in the subjugation of the coast settlements, Pizarro marched inland to the city of Cajamarca, where he captured Atahualpa, the Inca emperor, by one of the treacherous acts for which he was noted. Fearlessly accepting the invitation of the Spanish commander to visit him, Atahualpa, attended by crowds of his unarmed followers, arrived at the camp. At a signal Pizarro and his men seized the Inca emperor, and the rest of the Spaniards fell on the Indians and slaughtered 2,000 of them. Atahualpa offered, by way of ransom, to fill with gold a room 22 feet long and 17 feet wide to a point as high as a man could reach, and to fill it twice over with silver. Pizarro accepted the offer, received the precious metal, estimated as worth more than $15,000,000, but soon after had Atahualpa tried and executed on charges of murder and treason.

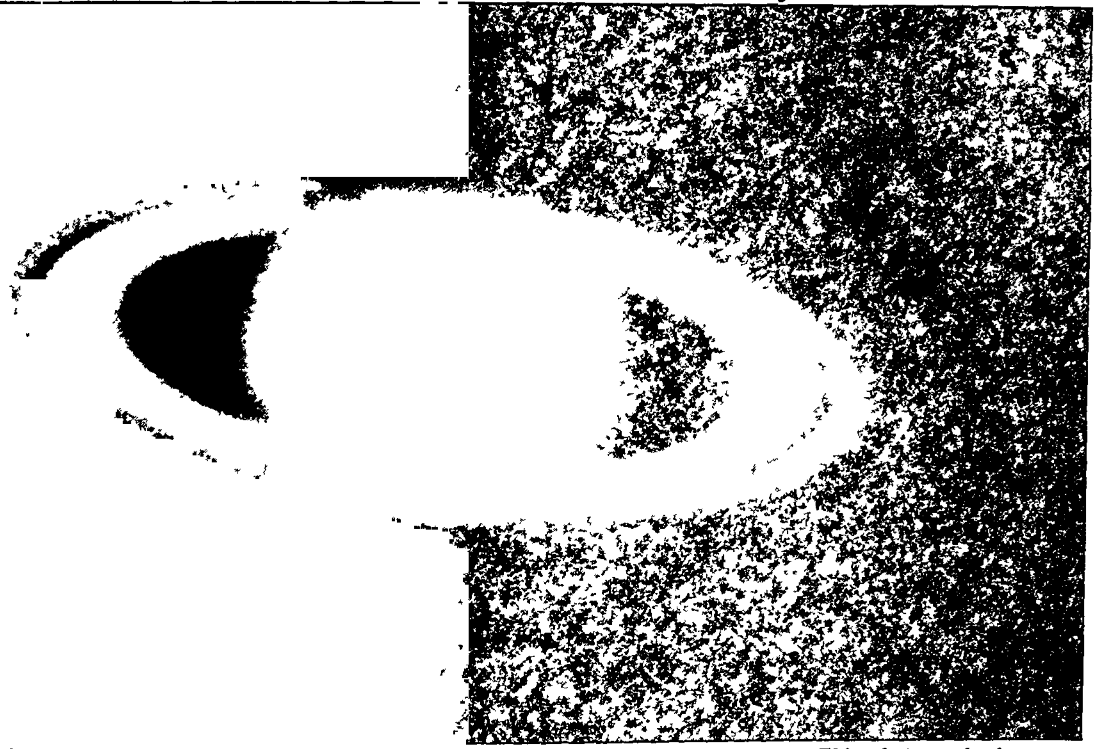
PIZARRO, CONQUEROR OF PERU



The martial energy of Francisco Pizarro animates this bronze statue of the conqueror of Peru by Charles Cary Rumsey, American sculptor. Notice the 16th-century armor for both horse and rider.

Pizarro then marched to Cuzco, and set up the young Inca, Manco, as nominal sovereign. In 1535 he founded the *Ciudad de los Reyes* (city of the kings) now Lima, the present capital of Peru, as the capital of his new government. Manco escaped and headed an unsuccessful uprising. Two or three years later a fierce quarrel arose between Pizarro and Almagro concerning the territory each was to govern. This contest assumed the proportions of a civil war and resulted in the capture and execution of Almagro. But the embittered and discontented followers of Almagro conspired against Pizarro and finally assassinated him on June 26, 1541. In a glass case in the cathedral of Lima are a pile of moldering bones, said to be those of the pitiless conqueror of Peru. (*See also* Incas; Peru; South America.)

The NINE PLANETS—*Children of the* SUN



Saturn with its rings and its cloud-streaked atmosphere is the most spectacular of the planets. This photograph shows how it looks through a 6-inch telescope. The dark dividing line between the two outer rings is called Cassini's division.

PLANETS. Most people can recognize some of the bright planets. They know that Venus is the brilliant starlike object which appears sometimes in the western sky at dusk and at other times in the east at dawn. They can point out Jupiter, which is also brighter than any star, and can recognize Mars by its red color. Fewer people can identify Saturn, and still fewer have ever noticed the elusive Mercury, appearing near the horizon as an evening or morning star. These are the bright planets. Uranus is barely visible to the unaided eye, while Neptune and Pluto can be seen only with the telescope.

One way to tell a large planet from a star is by its steady light. Stars twinkle because the atmosphere constantly causes slight deviations of their pin-point light rays. The planets, being so much nearer, send to us beams of light so broad that the atmospheric effect is scarcely noticeable. Planets can also be identified by their motion. If you are in doubt about a bright, starlike object, watch it from week to week. If it changes place relative to near-by stars, it is a planet. The ancient Greeks invented the name, which in their language means "wanderer."

Motions of the Planets

The planets, like the earth, belong to the solar system and revolve around the sun. As we shall see, some are closer to the sun than the earth is, others are much farther away, and no two of them make the trip around the sun in the same length of time. With these facts in mind, we can understand their motions in the heavens, which otherwise might appear to be extremely erratic.

Because the earth rotates on its axis, the planets, like all other heavenly bodies, seem to sweep across the sky each day from east to west (*see* Earth). But the motions that are likely to be confusing are those which the planets make relative to one another and to the background of the stars.

Compared to the stars, the planets are very close to us. If we draw a picture of the solar system, showing the most remote planet at three feet from the sun, then, to be accurate, we will have to place the nearest star about four *miles* away. Astronomers know from extremely delicate calculations that the stars have independent motions, some rushing closer together, others drawing apart. But their distances from us are so great that we cannot observe these motions directly, and the stars seem today to form the same unchanging pattern in the sky as they did in the days of the ancient Egyptian and Chaldean astronomers. The planets, on the other hand, are close enough to us to show their motions plainly.

They travel around the sun in the same direction as does the earth. If we imagine ourselves looking down on the solar system from above the North Pole, this direction is counterclockwise. To an observer on the sun, therefore, they would all be moving along their orbits from west to east. But because of the earth's position and its own motion around the sun, the planets appear to move part of the time from west to east across the stars (*direct* motion) and part of the time from east to west (*retrograde* motion).

The occasional retrograde or backward motion can be explained with Mars as an example. This planet

does not move as rapidly as the earth along its orbit, and at times the earth overtakes and passes it. When this happens, Mars seems to turn back for a time, just as a train falls behind when we pass it on a faster train.

Planets as a Group

All the planets, the earth included, differ from the sun and the stars in one important way. The sun and the stars are huge globes of glowing hot gas, and hence they give off light. The planets are all cool and solid, like the earth, and do not give off light of their own. They shine because they reflect light from the sun.

The planets are small compared to the sun and the stars; but they appear large enough to show as disks, even in small telescopes, because they are relatively near to us. These comparatively large-appearing surfaces reflect light enough to make the planets brighter than any of the stars.

The principal planets present much variety, as the accompanying table shows. In it are listed the nine principal planets, including the earth, as distinguished from many hundreds of minor planets, called planetoids or asteroids, which steer their courses mostly between the orbits of Mars and Jupiter (*see* Asteroids). The principal planets are classified in two ways: (1) The inferior planets, Mercury and Venus, revolve within the earth's orbit, while the superior planets revolve outside the earth's orbit. (2) If the division is made at the zone of the asteroids, the inner planets are Mercury, Venus, Earth, and Mars; the outer planets are Jupiter, Saturn, Uranus, Neptune, and Pluto.

Tiny Mercury

Mercury is the smallest principal planet, the nearest of all to the sun, and the speediest in its motion along its orbit. It revolves around the sun once every 88 days, and it overtakes the earth once every 116 days on the average.

Because of its small orbit, Mercury never seems to appear more than 28 degrees away from the sun. Hence we only see it after sunset, when it is at its greatest *eastern elongation* (meaning highest above the setting sun for observers in the United States), or before sunrise at its greatest *western elongation* (meaning highest above the rising sun). At these times it is the evening or morning star, and it often twinkles because of its small size and low altitude. At other times, it is in the sky together with the sun, and it is lost in the glare of the sunlight.

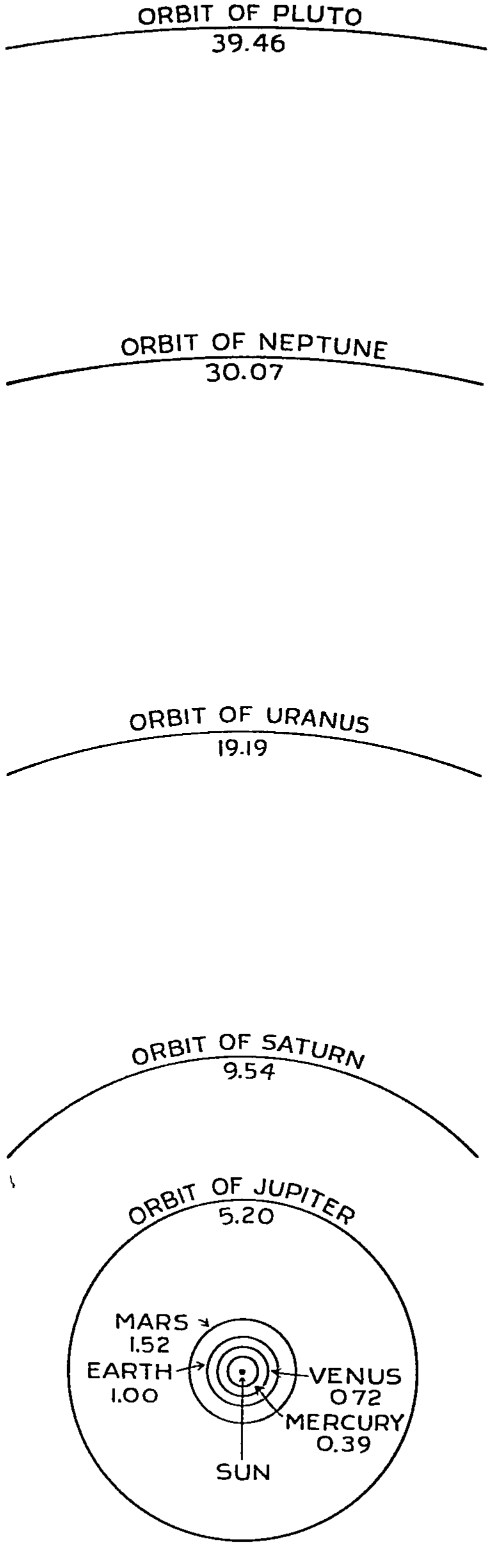
Usually as it moves between its positions above or below the sun, it passes to one side; but about 13 times a century it *transits*, or crosses the sun's disk. The nearest date for such a transit is Nov. 14, 1953.

Like the moon, Mercury has no atmosphere. Also it rotates once upon its axis during one revolution around the sun, and so it always presents the same face to the sun. This keeps the sunward side hot enough to melt tin or lead, while the other side is almost as cold as outer space.

Venus, "Twin Sister" of the Earth

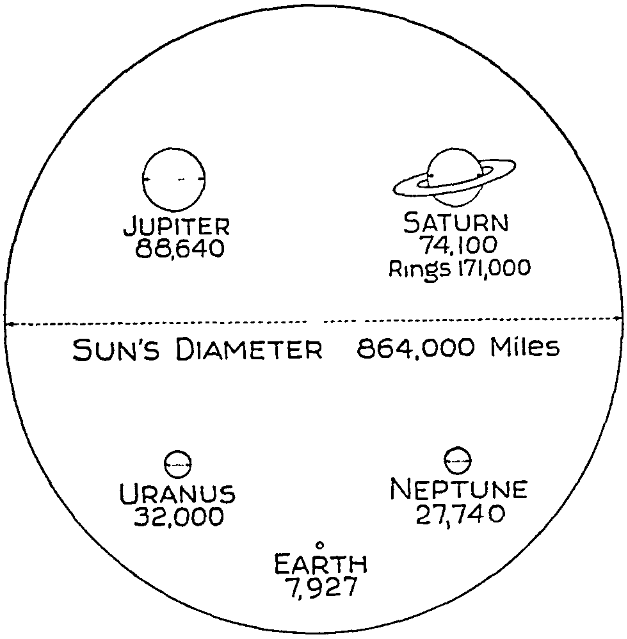
Since the orbit of Venus is inside that of the earth, the planet seems to move from side to side of the sun, like Mercury, and at times passes between us and the sun. Hence it shows "full," "half," and "new" phases, like the moon (*see* Moon). The "full" and "new" phases occur at *conjunction*—that is, when Venus is in line with the

ORBITS OF THE PLANETS



This diagram shows the mean distances of the planets from the sun in astronomical units. The earth's mean distance from the sun is equal to one astronomical unit. Equivalent distances in millions of miles are given in the table on the opposite page.

HOW THE PLANETS COMPARE IN SIZE



Here the larger planets are drawn to scale against a disk representing the sun. On this same scale the smaller planets—Mercury, Venus, Mars, and Pluto—would appear as mere dots.

sun and the earth. The full phase occurs when Venus is on the other side of the sun from us, and rises almost with the sun, as a morning star. The "new" phase, which looks like a crescent, occurs when Venus is between us and the sun, and appears as the evening star. Venus is brightest, however, about 36 days before and after the crescent phase. Then the surface is less than it is at full; but its nearness causes it to reflect the most light. Like Mercury, Venus usually passes the sun on one side or the other at conjunctions, with an occasional transit. The next one will occur in 2004.

The telescopic view of Venus is best in the daytime when the planet is high in the sky. Even then astronomers have rarely glimpsed any markings, and these are only clouds. Photographs with blue filters bring these out more clearly. Photographs with red filters, which are more effective in penetrating a murky medium, show nothing of the surface.

Since Venus resembles the earth in some respects and is not very much nearer the sun, people often ask whether it might not have some form of life. The astronomer answers cautiously, because he is unable to observe the planet's surface. But as far down through the atmosphere as he can see, the evidence is unfavorable. Spectroscopic studies show no trace of the free oxygen that is essential to human life as we know it.

Mars

Mars is the red planet. It is considerably smaller than the earth, having a diameter of 4,200 miles, or only twice the moon's diameter. It is nearest to us of the principal planets that revolve outside the earth's orbit. Mars goes around the sun once in 687 days and the faster-moving earth overtakes it every 780 days. The planet is then at *opposition*—that is to say, opposite the sun's place in the sky and nearer us than usual.

Favorable oppositions occur when Mars is also nearest the sun. These come at intervals of 15, or sometimes 17 years, when the planet's distance from the earth may be as little as 35 million miles. Favorable oppositions always occur in the late summer or early fall. Then Mars becomes the brightest starlike object in the sky except Venus.

The surface features of Mars are not completely hidden by the surrounding atmosphere. At times they show well in a large telescope. Greenish blotches are observed on the orange surface of the planet and are known by watery names, like the "seas" on the moon; but they are not bodies of water. Finer markings have been called "canals." White caps are seen at the poles. Each cap grows larger during the winter in that hemisphere and diminishes as summer approaches, like the caps of snow and ice around the poles of the earth. The seasons of Mars resemble ours, except that they are longer.

The atmosphere of Mars is rarer than the earth's atmosphere. Water is scarce. The temperature is low, but it rises above freezing at noon in the tropics. Human life could perhaps exist under such conditions. Yet the failure to detect a trace of oxygen in the Martian atmosphere with a spectroscope argues against the possibility. The possibility of plant life is somewhat

THE PRINCIPAL PLANETS

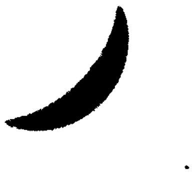
Name	*Symbol*	*Mean Distance from Sun*	*Period of Revolution*		*Equatorial Diameter*	*Period of Rotation*
		Million Miles	**Sidereal*	**Synodic*	*Miles*	
Mercury	☿	36.0	88.0 days	115.9 days	3,100	88 days
Venus	♀	67.2	224.7 days	583.9 days	7,700	30 days?
Earth	⊕	92.9	365.3 days	....	7,927	23^h56^m
Mars	♂	141.5	687.0 days	779.9 days	4,215	24 37
Jupiter	♃	483.2	11.9 years	398.9 days	88,640	9 50
Saturn	♄	885.9	29.5 years	378.1 days	74,100	10 14
Uranus	♅	1782	84.0 years	369.7 days	32,000	10 45
Neptune	♆	2793	164.8 years	367.5 days	27,740	15 48
Pluto	♇	3670	247.7 years	366.7 days	3,600	?

*The sidereal period is the true period of revolution as seen from the sun. The synodic period is the interval between the times when the planet overtakes the earth or the earth overtakes the planet in their revolutions around the sun.

The symbols for the first six planets have been used by astronomers and astrologers since ancient times. Designs such as a mirror for Venus suggest the divinity for which the planet was named. As the other planets were discovered, symbols in keeping with the ancient ones were adopted.

greater. The greenish markings become unmistakably greener with the coming of spring in that Martian hemisphere and fade during the autumn season, as they might do if they are areas of vegetation.

Two tiny satellites revolve around Mars; they are not more than ten miles in diameter. Phobos, the inner one, is only 5,800 miles from the center of the planet, or 3,700 miles from its surface. It revolves from west to east once in 7 hours 39 minutes, while Mars itself rotates on its axis in the same direction once in 24 hours 37 minutes. Phobos is the only satellite in the solar system that goes around its planet in a shorter period than that of the planet's rotation. As seen from Mars this satellite rises in the west and sets in the east. Deimos, the outer satellite, is 14,600 miles from the center of Mars and circles around it once in about 30 hours. This satellite, therefore, rises in the east in the Martian sky as our own moon does.



Through a telescope Venus looks like a crescent moon, when it is between the earth and the sun.

The "Giant" Planet Jupiter

Jupiter is the giant planet. Its equatorial diameter, 88,600 miles, is eleven times as great as the earth's diameter and its mass is greater than the combined masses of all the other planets. It is the brightest starlike object in the heavens, except Venus and occasionally Mars. Five times as far from the sun as the earth's distance, this planet revolves around the sun once in nearly 12 years. It is overtaken by the earth every 399 days and on each occasion is found about one constellation of the zodiac east of its former place.

Only a small telescope is needed to see a succession of dark streaks across the planet's disk. These are the "cloud bands" which separate the bright zones of the greatest cloudiness. What is seen is the outside of the extensive atmosphere; it is impossible to look through to the surface. Large telescopes show dark and bright spots as well, which at times change in form quite rapidly. Yet an elliptical spot about 30,000 miles long, the "great red spot," has persisted for a century or more.

This drawing of Mars shows a polar ice cap at the top, also the lines which some observers have considered canals. These observers suggest therefore that the planet must have intelligent inhabitants.

All these markings are carried around at different rates by the planet's rotation. Jupiter rotates on its axis in a little less than ten hours, the shortest rotation period of any of the principal planets. The decided flattening of the disk at the poles is a result of this swift rotation.

Sunlight is feeble at Jupiter's great distance from the sun, and the temperature of the atmosphere is 200° F. below zero. These clouds are surely not composed of water, because if water exists on the planet it must remain permanently frozen. Astronomers once wondered what could be evaporating at the surface and rising to condense into clouds. Rapid changes in the cloud formations suggest that this action must be vigorous. The spectroscope has solved the puzzle. Important constituents of the planet's atmosphere are ammonia and methane. These substances can evaporate in the extremely cold climate of Jupiter.

The telescope shows that Jupiter has four bright satellites. These satellites, discovered by Galileo in 1610, could be glimpsed without the telescope, if they were not obscured by the glare from the planet. Since their orbits are presented nearly edgewise to us, the satellites appear to move forward behind the planet and through its shadow, and then backward across its disk, casting shadows as they pass. The first and second satellites are about the size of the moon. The third and fourth are half again as great in diameter as the moon; these two are the largest satellites in the solar system and they surpass the planet Mercury. Jupiter has eight other satellites, but they are small and faint, even in telescopes.

Saturn and Its Rings

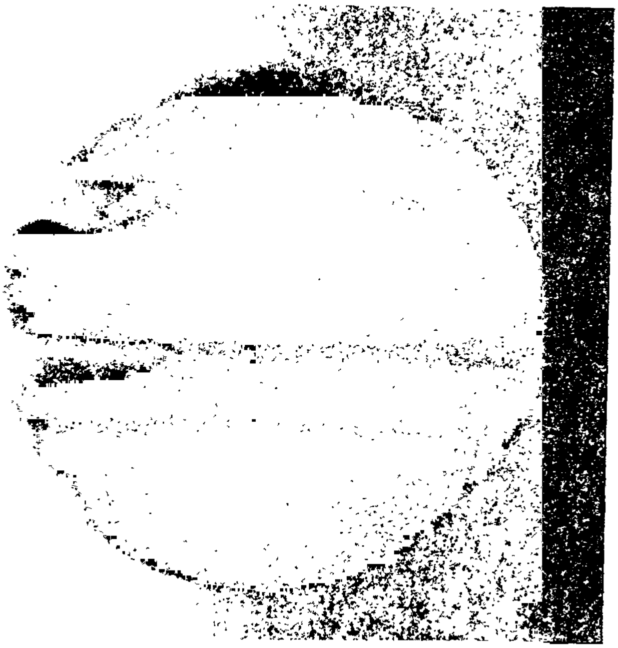
Saturn is the most remote of the bright planets, being about ten times the earth's distance from the sun, and it was long thought to be the outermost planet of all. It revolves around the sun once in 29½ years at the average distance of 886 million miles. With its equatorial diameter of 74,100 miles it is second in size to Jupiter. Saturn has nine known satellites. Titan, the largest, is 2,600 miles in diameter, or somewhat larger than the moon. Phoebe, the smallest and most distant from Saturn, revolves around the planet from east to west; the others revolve from west to east. The innermost five revolve in from about one to four days.

Like Jupiter, Saturn is surrounded by impenetrable atmosphere, with cloud bands running parallel to the Equator. All ammonia has been frozen out of the atmosphere, but methane is abundant. A few bright spots have been seen, going around in different periods. Those near the Equator suggest that Saturn rotates once in 10 hours 14 minutes.

Saturn is remarkable because of three encircling rings. These three concentric rings lie in the plane

of the planet's equator and extend outward 170,000 miles. The middle ring is the brightest; it is separated from the outer ring by a dark space called Cassini's division. The inner, or crepe ring, is very dim.

The rings are composed of many separate pieces, like tiny satellites. The pieces reflect sunlight, which runs together to give the appearance of continuous surfaces. The Cassini division is a narrow zone where practically no pieces exist, while in the crepe ring the pieces are evidently widely spaced.

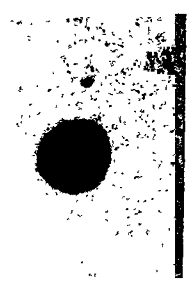


An ultraviolet filter helped obtain this fine photograph of Jupiter, showing the huge bands of clouds which usually streak the atmosphere of this giant planet.

The rings are inclined 27 degrees to the plane of the planet's orbit. First the northern face of the rings, and then the southern, is presented to the earth. During short periods about 15 years apart, the rings are edgewise to the sun and, at times within each period, to the earth. At such times, the rings cannot be seen except with the largest telescopes.

Uranus, Neptune, and Pluto

Nobody supposed that a more remote planet existed beyond Saturn, until William Herschel of England discovered Uranus accidentally in 1781. Soon this planet puzzled astronomers because it did not follow the expected course. In 1846 Leverrier of France found the answer to the puzzle. His calculations suggested that Uranus was drawn from the predicted path by a planet still more remote, and he predicted the place of the disturber in the heavens. Galle in Germany pointed his telescope in that direction and identified the new planet. That was the planet which was later named Neptune.



A large telescope discloses Neptune and one of its satellites.

Uranus can be glimpsed with the unaided eye. Nineteen times as far from the sun as the earth's distance, it revolves around the sun once in 84 years. It is attended by five satellites, which have orbits nearly at right angles to the plane of the planet's orbit.

Neptune is always invisible to the unaided eye. Its distance from the sun is thirty times as great as ours, and its period of revolution around the sun is 165 years. Neptune has two known satellites, one about 2,800 miles in diameter and the other only 200 miles. The smaller of these was not discovered until 1949. The larger satellite is known to circle the planet from east to west. Uranus and Neptune show no surface markings.

Pluto is the most remote of the known principal planets. It was discovered in 1930 at the Lowell Observatory by Clyde Tombaugh. Its existence had been suspected because some very slight irregularities remained in the motion of Uranus after taking account of the attraction from Neptune. Pluto was found about as predicted, but it proved to be too small to account for all the disturbances in the orbit of Uranus.

Pluto is visible only through large telescopes. Its diameter is about one-half that of the earth, and its yellow color suggests that it has very little atmosphere. Pluto revolves around the sun once in 248 years, at an average distance 40 times our distance from the sun. Its orbit is so eccentric, however, that part of it lies inside the orbit of Neptune.

Origin and Motions of the Planets

Modern attempts to explain the origin of the planets began in the 18th century when Immanuel Kant and Pierre Simon Laplace suggested that a cloud of dust or gas had condensed into the solar system. Laplace's *nebular hypothesis* was mathematically impossible, however, and it was abandoned. About 1900 Thomas C. Chamberlin and Forest R. Moulton proposed the *planetesimal* theory and later Sir James Jeans and Harold Jeffreys advanced the *gaseous-tidal* theory. Both hypotheses assumed that a near collision of the sun and another star had produced the planets (*see* Earth). Objections to these theories led scientists to reconsider the dust-cloud hypothesis. In 1952 Harold C. Urey supported this theory with evidence that the planets may have developed by the accumulation of small, cold particles, which grew hot as they packed together.

The orbit of every planet is an ellipse, with the sun at one focus. The amount of deviation from a circle is its *eccentricity*. The eccentricity of most planets' orbits is slight, but for Mercury the figure is 20 per cent and for Pluto 25 per cent. The orbits of all planets except these two also lie very nearly in the same plane. The shape of the planets' orbits, the law governing their speeds, and the law governing their periods of revolution were discovered by Johann Kepler early in the 17th century. His work was based on observations of Tycho Brake (*see* Kepler).

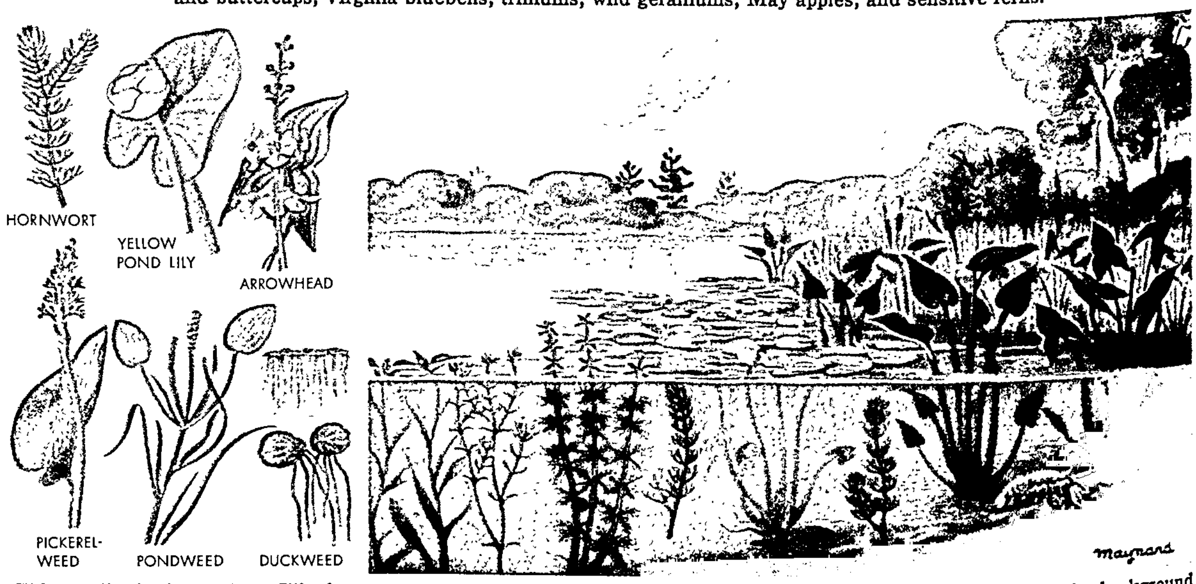
PLANTS—*How They* LIVE *and* MAKE FOOD

PLANT LIFE. Wherever they can find sunlight, air, or some earth plants will grow. On the northernmost coast of Greenland the Arctic poppy peeps out from beneath the ice. In the dismal Antarctic grow mosses and tussock grass. Flowers of vivid color and great variety force their way up through the snows of mountainsides. In the heart of the burning desert, the aloe and cactus find a way to live. Rivers, lakes, and swamps are filled with water plants. Very simple plants, such as some kinds of bacteria, yeasts, and molds, don't even need sunlight and earth, but live and multiply in darkness. In fact, almost the only place one *cannot* find plant life is in the black deeps of the sea.

We could not live without plants. All our food depends directly or indirectly upon them. Our meat comes from plant-eating animals. Our drinks, except water, come from plants—coffee, tea, cocoa, lemonade and even milk, which comes from plant-eating animals. Flavoring extracts and many medicines are plant prod-

ILLINOIS WOODLAND AND LAKE

In late May the hardwood forests of the Middle Western states are most beautiful. The buds of the trees, the seeds in the soil, the resting plants that have lived through the winter by means of food stored in underground roots and stems burst into bloom with the warmth and sunshine. Among the trees are maple, elm, linden, white ash, and white oak. In their shade grow violets and buttercups, Virginia bluebells, trilliums, wild geraniums, May apples, and sensitive ferns.



This small lake in northern Illinois supports many kinds of plants. Around the shallow shores grow cattails (in the background at the right), arrowhead, pond lilies, and pickerelweed. Pondweed and duckweed in the deeper portions are a favorite food of ducks, coots, and geese. Duckweeds are tiny plants that crowd together in blankets on the surface of the water. Hornwort and various other plants grow in thick beds that shelter snails, worms, and small fish.

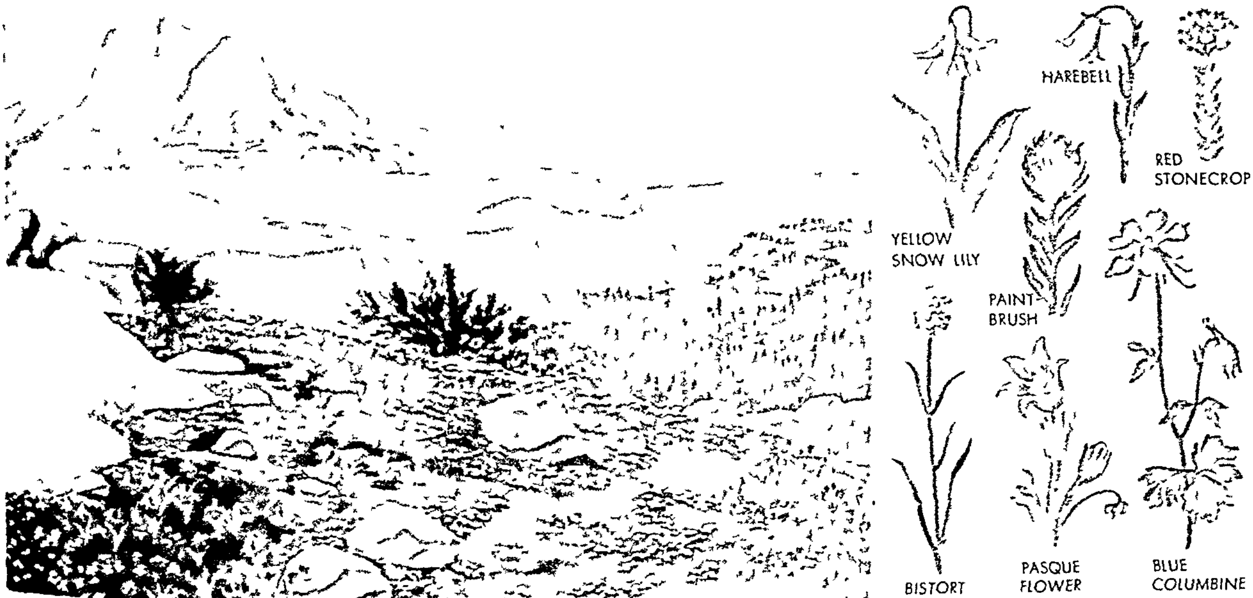
ucts. Most of our clothing comes from plants—cotton, linen, and rubber from plants directly, wool and silk from plant-eating animals. Plants provide us with wood for houses and furniture and for hundreds of other products, including paper.

The simple plants called bacteria and fungi cause some diseases, but they also have other very valuable functions. Yeast is a fungus which makes bread rise, and it has many other uses. Most processes of decay and fermentation are due to bacteria. When an animal dies in the woods, when a tree falls, their remains are rotted by bacteria or fungi. The life-giving substances of which they were composed return to the soil and enrich it for the use of new life. The simple plants help to form soil itself. On many rocks grows a crusty, gray-green material called lichen. Beneath it the rock is beginning to crumble. Lichens are among the first plants to grow on bare rock and by their chemical action they break it down into soil.

How Plants and Animals Differ

Exactly what is a plant and how is it different from an animal? Perhaps that seems like a foolish question. Everyone knows that an elm tree is a plant and that a dog is an animal. The answer is not so easy

MOUNTAIN MEADOW AND SEASHORE

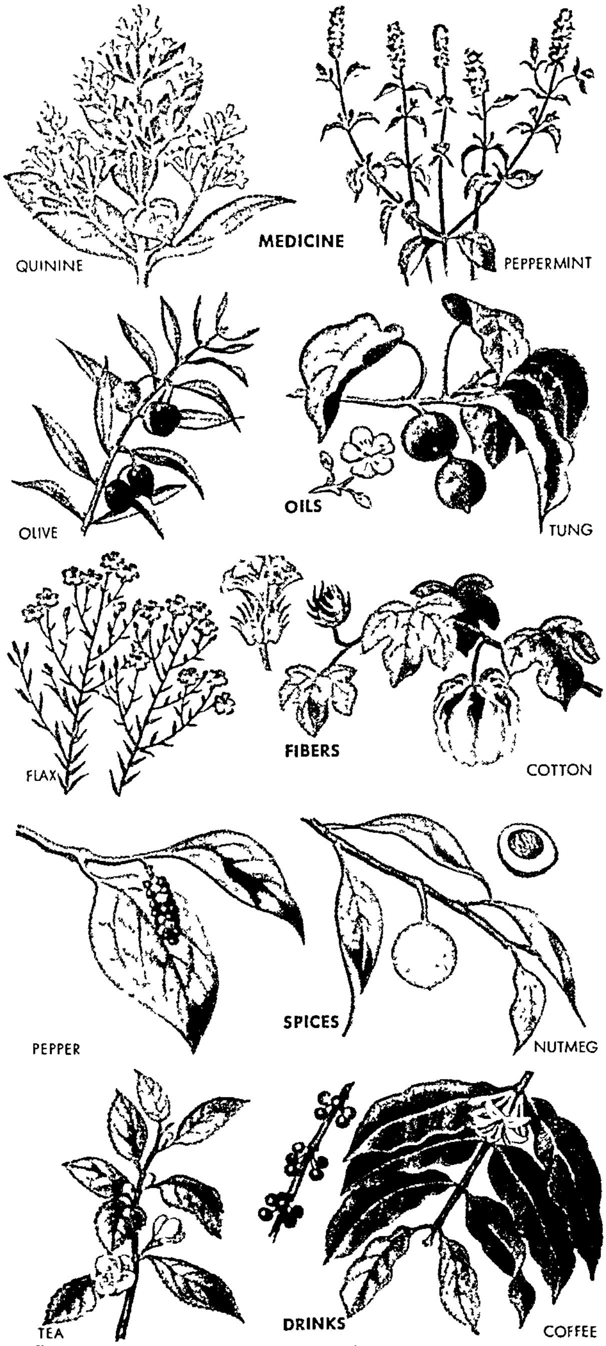


This scene shows a meadow 12,000 feet high in the Medicine Bow Range, near Laramie, Wyo. In the valley (right) evergreen trees grow to full height. Up here where the winds are strong and cold, the trees are dwarf juniper (edge of snowfield), and prostrate spruce (center). Intense sunlight and the short growing season, June to August, make countless flowers burst into bloom at one time. These same flowers in the lowlands would bloom in succession from spring through autumn.

This is a stretch of seashore on the Bay of Fundy. Twice a day the lower levels are covered by the rising tide. Attached to the rocks grow hundreds of kinds of seaweeds and other algae. Some kinds grow only under water; others only in moist places. Still others must be under water part of the day and exposed to the air part of the day. (The four scenes on these two pages are based on dioramas in the Chicago Natural History Museum.)

when one is studying the very simplest plants and the simplest animals—such as the one-celled bacteria and the protozoa. What are the slime molds which creep as white or brightly colored films over damp rotting wood in shady places? Some scientists put these doubtful plant-animals into special groups of their own (*see* Life).

PLANTS ARE USED IN MANY WAYS



Here are a few of the plants on which we depend for food and for most of the necessities of life. Everyone could name dozens more. Some, such as tea, coffee, and quinine, cannot grow in the United States and must be imported from other lands. We use the fibers of some, the fruits, bark, leaves, or roots of others.

One thing plants and animals have in common. Both are *alive*. Living things are made up of *protoplasm*, a colorless material like the white of a raw egg. Protoplasm is put together in tiny packages called cells. All living things, plants and animals, are made up of cells of protoplasm.

The walls of plant cells are made of cellulose. This is the stiffening material in tree trunks, twigs, the veins of leaves, celery stalks, cork, cotton fibers, and so on (*see* Cellulose). One difference between plants and animals is that plants contain cellulose and animals do not.

Nearly all the familiar plants are green. This greenness is caused by another wonderful material called *chlorophyll*. No animal contains chlorophyll. This is another great difference between plants and animals. All animals eat ready-made food, either plants or other animals. Green plants make their own food. This is a third difference. From water and minerals in the ground and from gases in the air they make sugars, starches, fats, and proteins. They do so by means of the green chlorophyll.

Still another difference is that animals move about freely by their own efforts. Plants have movements, such as turning toward light and reaching toward water, but these are different from the movements of animals. Finally, plants do not see, hear, feel, taste, or smell. Those that reach toward light do not do so because they see it. The "sensitive plants" that wilt at a touch do not feel the touch.

The wise men who wrote the books of the Bible spoke of about 200 kinds of plants. Today the scientists called *botanists* have named and described more than 250,000 kinds. About 2,000 new kinds are discovered or developed every year. Botanists divide plants into several groups, arranged in order from the simplest to the most complex.

The Algae and Fungi

The most primitive group of plants are the algae and the fungi. The plant body is made up of ribbons or masses of tissue not divided into roots, stems, and leaves. Such a plant body is called a *thallus*, and the name of the group is *Thallophyte*. The ending *phyte* comes from a Greek word meaning "plant." A thallophyte is, then, a plant having a thallus type of body.

Algae are the simplest of the green plants. From them all other plants are believed to have developed. Most of them live in fresh or salt water. Algae form the familiar green "scum" on the surface of still waters. The microscopic diatoms with their beautifully shaped, glasslike shells; the giant kelp of the oceans, which sometimes measures more than 150 feet from base to tip; the seaweed which waves from its moorings on rocks on the shore, all are algae. The redness of the Red Sea is caused by algae in which the plant's greenness is hidden by red pigment. (*See also* Algae; Diatoms; Seaweed.)

Fungi do not contain green coloring matter. They get their food from the living or dead bodies of other plants or animals. If they feed on living materials

they are called *parasites;* if they get food from decaying remains of plants and animals they are called *saprophytes.* The bacteria of disease, the blights and rusts, the various forms of rot on growing fruit are examples of parasites. Mushrooms and toadstools, bracket fungi and puffballs are saprophytes. (*See also* Bacteria; Fungi; Mildews and Molds; Mushrooms; Rusts and Smuts; Yeast.)

A lichen is an odd plant formed by a fungus and an alga living so closely together that they appear to be a single plant. Lichens grow on the rocks and trees of damp woods, on deserts, arctic tundras, and high mountainsides. Most of those familiar in the United States are crusty or leaflike in appearance. The "reindeer moss," on which animals of the far northern tundras feed, is a lichen (*see* Lichens).

The First Dry-Land Plants

The earliest plants to become adapted to living on dry land were the liverworts and mosses. They form the second group in the plant kingdom, called the *Bryophytes.* "Bryon" is the Greek word for moss. Liverworts are green plants which grow in moist places. They have simple or no stems, simple leaves, or flat green bodies that resemble leaves. On their under surfaces are rootlike structures but not true roots. Mosses show the beginnings of leaves, stems, and roots. They are the first green plants to stand erect. The algae and liverworts are supported by water or they lie flat on the ground, on bark, or on the leaves of other plants (*see* Liverwort; Moss).

The highest types of plants without flowers are the ferns, club mosses, and horsetails. They are the *Pteridophytes* (from "pteris," the Greek word for fern). They are common in shaded woods and on the edge of water although they live in many other places. They have leaves, roots, and stems but no flowers. Millions of years ago the ancestors of the ferns were the largest of plants. They covered the earth in vast forests. Their remains form the coal beds in the earth today. In the tropics ferns still grow as big as trees, but in the forests of temperate climates they are small shade-loving plants (*see* Fern).

Club mosses are the "ground pines" often used for Christmas decorations. They are usually a few inches high, with slender, simple or branching stems and small scalelike leaves. They look like little pine trees, with tiny club-shaped cones at the tips of the branches.

Horsetails are small plants usually less than three feet tall. They grow in moist places along streams and in swamps. Their jointed stems look somewhat like bamboo. The scaly leaves grow in whorls around the stem at the joints. There are cones at the tops of the branches. Horsetails are sometimes called scouring rushes because pioneer women used them to scour pots and pans. They contain silica, a harsh, sandlike substance.

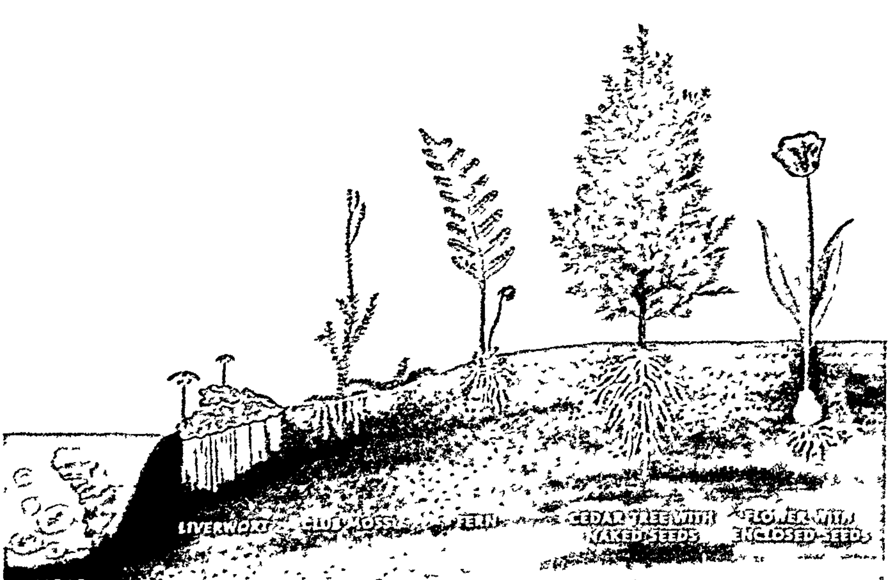
The Flowering, or Seed, Plants

The last and most highly developed group are the flowering plants, or seed plants. They are called *Spermatophytes* from the Greek word "sperma," meaning seeds. This group contains more members than all the other plant groups put together. There are more than 200,000 different kinds. They range in size from the duckweed, no bigger than the head of a pin, to the great eucalyptus of Australia and the giant sequoia of California. All the colorful flowering plants belong to this group, as do the trees, grasses, grains, vegetables, and weeds.

The flowering, or seed, plants are divided into two types. Those with naked, or exposed, seeds are called *gymnosperms.* The seeds lie on the scales of cones. Evergreen trees such as pines and spruces belong to this type (*see* Trees). Those of the second type are called *angiosperms,* meaning "enclosed seeds"; that is, the seeds are protected inside a fruit (see Flowers; Seeds). The enclosed seed plants are millions of years younger than the naked seed plants.

Seed plants fall into three general groups. They are called *trees* if they have a tall, woody stem (trunk), usually eight feet or more in height. *Shrubs* are low, woody plants, usually with many stems, branching close to the ground. Trees and shrubs are *perennials;* that is, they go on living year after year. *Herbs* have tender juicy stems in which the woody tissue is much less developed than in the shrubs and

THE STORY OF PLANT EVOLUTION



Algae are very simple water plants. Liverworts were among the first plants to grow on land. Club mosses developed the first roots and stems, with scales in place of leaves. Leaves first appear in the ferns. Conifer trees have seeds, but cones take the place of flowers. Flowers are the highest development of the plant world. These pictures are not drawn to scale. The algae are very small and no tulips or fern fronds are as tall as trees

MOUNTAINTOP TREE BENDS WITH THE WIND

This Jeffrey pine is on a mountaintop in Yosemite National Park. Flattened in the direction of the winds, it is not uprooted. Such trees become stunted and deformed.

trees. They are *annuals* or *biennials*, living one or two years, or *perennials*, living three or more years. Most of the grasses are herbs, but the bamboos, which are members of the grass family, are often woody-stemmed and may be either trees, shrubs, vines, or herbs. All three groups have the same organs and live and grow in the same way.

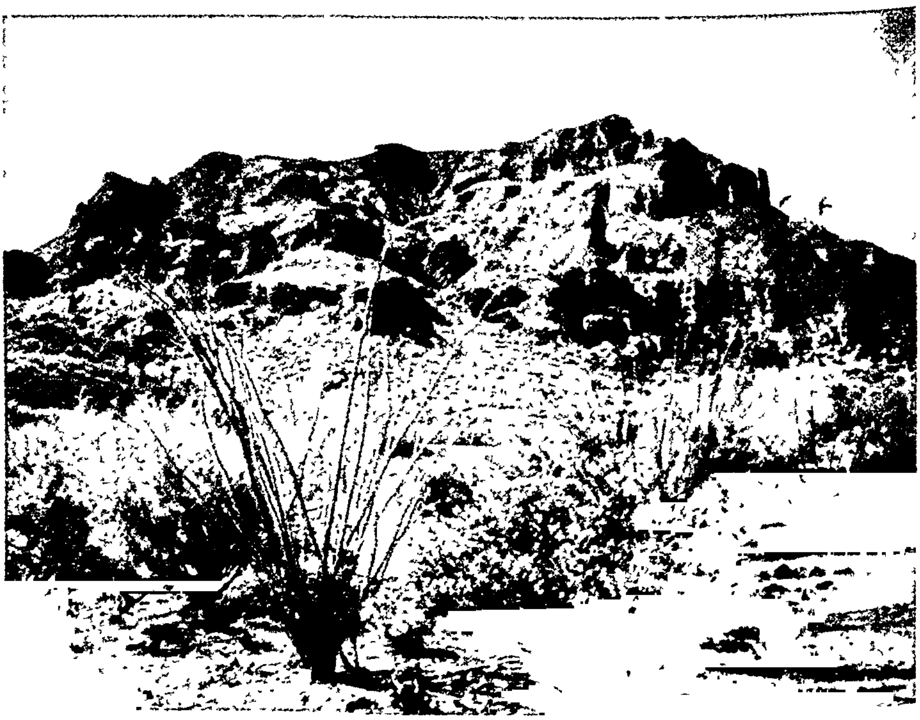
Green plants may well be thought of as food factories. They are very important factories, for without them there would be no food for man and the other animals.

Roots—the Receiving Rooms

The roots may be called the receiving rooms of the factory, for one of their chief purposes is to draw in raw materials from the soil. Rain water as it

COLORFUL FLOWERS BLOOM ON DESERTS

Desert plants need little water. They bloom and produce seed rapidly during the infrequent rains of spring. The scarlet flowers of the ocotillo are on a thorny shrub with whip-like, unbranched stems. The yellow flowering shrubs are paloverdes. In the foreground is sagebrush. This scene is in the Boyce Thompson Southwestern Arboretum, near Superior, Ariz.



CYPRESS TREES THRIVE IN SWAMPS

Plants are adapted to different conditions in many ways. The bald cypress in the Big Cypress Swamp of Florida sends out knobby "knees" (foreground and along shore line) from its roots The knobs are spongy and seem to provide the underwater roots with air. From the trees hang gray wisps of Spanish moss. This air plant has no roots. It gets sunlight by clinging to the upper branches of the trees.

filters into the soil dissolves the minerals in the soil. The plant uses this solution of water and minerals for its work of making food. The second purpose of roots is to anchor the plant to the soil.

When a seed sprouts, the first thing to break out of the coat is the root (called the *radicle* at this early stage). No matter what the position of the seed when it is planted, whether sideways or upside down, the root turns downward. It always turns toward darkness and away from light.

The most important part of a root is its tip and the root hairs just behind the tip. One seldom sees them, for when a plant is pulled up, they are broken off. This is why flowers and trees that are to be transplanted must be carefully dug up with a ball of earth to which the roots are fastened. (The article Root tells about the different kinds of roots and the work of the tip and the root hairs.)

Roots take in enormous quantities of water. Most of it (about 96 per cent) is passed into the air through the leaves by a process called *transpiration*. It has been estimated that a single oak tree gives off 90 to 100 gallons of water a day. All this water has to enter the plant through its roots. No wonder they are long and wide-spreading. The root system of a single oat plant, including its root hairs, occupies

only a cubic yard of soil, but it may measure a total of 450 feet. One corn plant, growing through 225 cubic feet of soil, had more than 1,300 feet of root.

Drawing in Water by Osmosis

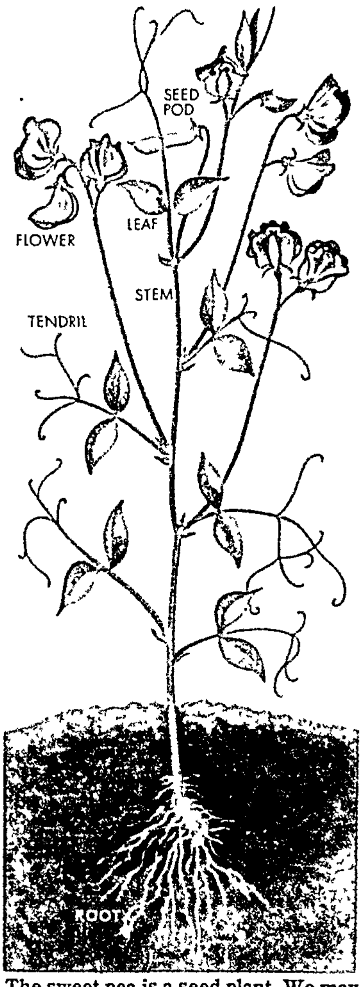
The way plants draw water from the soil is one of the marvels of science. It can be illustrated as follows: Fasten a small sack made of some membrane, such as sausage casing, over one end of a long glass tube and pour into the tube a sugar solution. Now put this sack end of the tube into a jar of water. Water will be drawn from the jar through the membrane, and the liquid mixture will rise in the tube —without a visible force or disturbance of any kind. The process is called osmosis. It always takes place when two liquids, one of them containing some other substance in solution, are separated from each other by a suitable membrane. The liquid of weaker concentration passes through the membrane and mixes with the stronger.

This is what happens in plants. Among the things made by the plant is sugar, which is dissolved and distributed in the form of *sap* through each living cell in the entire plant. The outer covering of the root hairs is a membrane and so is the wall of each individual cell.

As water is absorbed into the root hairs, it is pushed upward by the press of water molecules behind it (osmotic pressure). At the same time evaporation from the leaves exerts a pull upward. Aided further by the tendency of water molecules to cling together (cohesion), pushed from below, and pulled from above, the water rises in an unbroken column.

Enormous force is exerted. The pressure of the sap in a tree may be hundreds of pounds per square inch. It is this pressure which helps to hold young stems and flowers upright and which causes overripe fruit to burst. It supplies the energy by which buds and flowers swell and unfold. It forces roots through great rocks and well casings and lifts concrete sidewalks.

THE PARTS OF A PLANT



The sweet pea is a seed plant. We may call plants food factories. Roots are the receiving rooms. Stems are the transportation system. Leaves are the chemical laboratories. The sun is the source of energy.

Stems, the Transportation System

After the water is absorbed by the roots it passes up through the stem to the leaves. This brings us to the second important part of the plant, its transportation system. Inside the stem are tubes, called *vascular bundles*. "Vascular" means a small vessel for carrying a liquid. One set of tubes carries water upward to the leaves. Another set carries food downward from the leaves to the places where it is to be used or stored. In order to be transported in the plant, food must be in solution. The sugar manufactured by the leaves is dissolved in water. The minerals brought up from the soil are in the form of dissolved salts. The fluid which carries these food materials is *sap*.

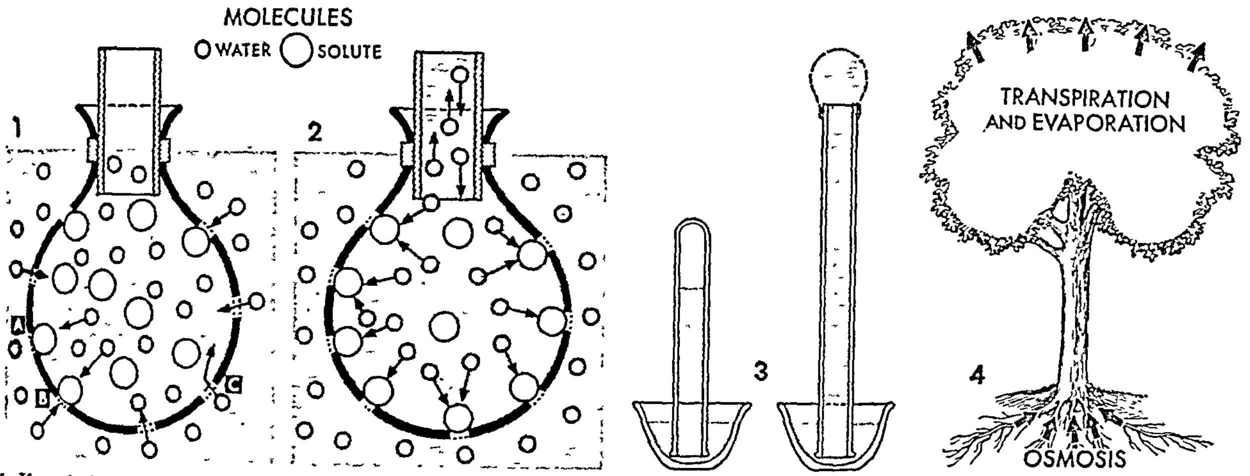
Seed plants are divided into two groups on the basis of the formation of their seed leaves and the arrangement of the vascular bundles. Plants with two seed leaves have the bundles arranged in a circle around a central pith. They are called *dicotyledons* (*dī-kŏt-ĭ-lē′dŏnz*), often shortened to "dicots" (*dī′kŏts*). Beans, most of the trees and shrubs, and many flowers are dicots. One way to recognize them is by the veining of their leaves. Most dicots have the veins in the form of a network.

A tree trunk is a typical dicot stem. The stump of a tree that has been chopped down shows the same kind of rings as those in the stem of a violet viewed under a microscope. (For diagram, *see* Tree.) The outer layer is called the *cortex*. In woody plants it is known as bark (*see* Bark).

Inside the cortex are the vascular bundles. They consist of three tissues. The *phloem* (*flō′ĕm*), toward the outside of the stem, conducts food downward. The *xylem* (*zī′lĕm*), toward the inside of the stem, conducts water upward. Between the phloem and the xylem is the *cambium*. This is the growing layer, which produces phloem cells on one side and xylem cells on the other. Growth in the diameter of a stem takes place in the cambium layer. The center of the stem is the pith, which serves as a storage place for reserve food.

Plants with one seed leaf have the bundles in the form of strands running the length of the stem. Such plants are called *monocotyledons* (*mŏn-ō-kŏt-ĭ-lē′-dŏnz*). You may recognize them by the leaves with the veins running mostly parallel to one another. Grasses, corn, bananas, palms, and lilies are among the "monocots." Monocot stems have an inconspicuous cortex and the two types of conducting tubes but no cambium and no central pith. Without cambium, such plants grow in height, but with the exception of palms they do not grow in the diameter of the stem.

HOW OSMOSIS WORKS AND PLANTS DRAW SAP TO THE TOP



1. If a solution of any substance is separated by a porous membrane from a weaker solution or plain water, molecules on each side of the membrane bombard it. If a molecule from inside drives a large molecule of dissolved substance (solute) ahead of it, the solute molecule can act to plug a pore and hold the water molecule inside (A and B). Water molecules from outside, however, usually can slip past such plugs (C). 2. These outside molecules gradually force liquid up in the tube. At a certain height, pressure from the raised liquid prevents further increase. This amounts to full osmotic pressure. 3. In a simple tube barometer, atmospheric pressure can hold up nearly 34 feet of water (at sea level). If a much taller tube is filled with water and the top has a porous membrane which lets water evaporate, forces of cohesion will pull on the column of water to replace the loss. 4. Force of cohesion and the osmotic pressure that is pushing liquid into the roots force sap to the top of the tree.

Vascular bundles divide into smaller bundles as they go into branches, twigs, leaf stalks, and finally into leaves. In the leaves we can see them as the veins. The veining of most dicot leaves differs from the veining of monocot leaves.

Food moves sideways into all parts of the plant, as well as up and down. Vascular rays and pith rays carry sap horizontally through the cell walls.

Leaves—the Chemical Laboratory

The most important part of the plant factory is the chemical laboratory—the leaves. In the presence of sunlight, the green coloring matter called *chlorophyll* combines water with carbon dioxide and produces a simple sugar. The process is known as *photosynthesis*. The word comes from Greek *photos* (meaning "light") and *synthesis* ("putting together"). All life on earth depends on photosynthesis. Without it there would be no plants and without plants there would be no animal life. Any plant that contains chlorophyll can make food. Some simple plants have chlorophyll in single cells. In the higher seed plants, the leaf is the chief food manufacturer.

Leaves usually turn their upper surface toward the sun, because most of the green coloring matter is located there. It is carried in special cells called *chloroplasts*. A single square inch of an elm leaf may have 250 million chloroplasts.

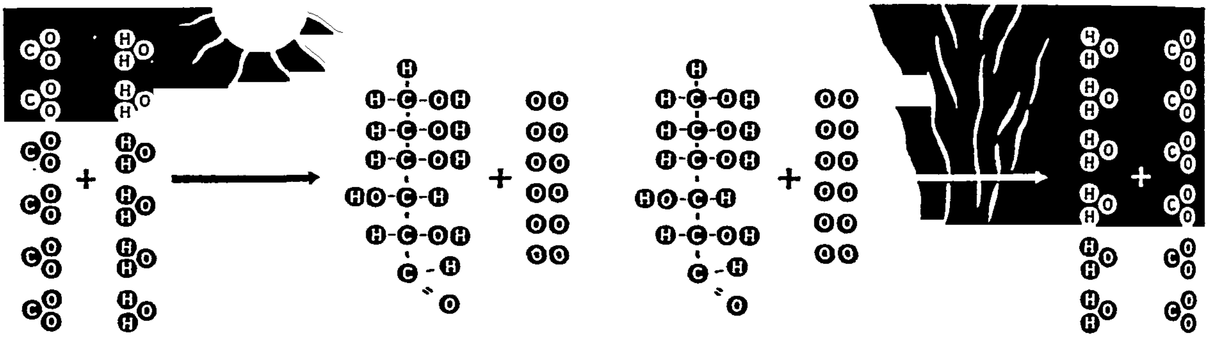
On the lower surface of the leaf there usually are tiny openings called *stomata* (singular, *stoma*). Stomata permit gases to enter the leaf and gases and water vapor to leave it (transpire) and evaporate into the air. An apple leaf may have 100,000 such openings. If they were on the side exposed to the sun, the leaf would lose too much water and would die. Some leaves turn their edges to the sun and have chloroplasts and stomata on both sides.

Carbon dioxide (CO_2) from the air enters the leaf through the stomata. Water (H_2O) travels

DELICATE ROOTS EXERT GREAT PRESSURE

The root tip is so important to the plant that it is protected from injury by a root cap as it pushes its way through the earth. These are roots of the cabbage palm (left), showing the root cap of one of them removed. The pressure of growing plants is great enough to split huge rocks apart (right). Pressure from roots can break concrete sidewalks and crack well casings open.

PHOTOSYNTHESIS AND RESPIRATION



Sunlight shining on the green coloring matter in plants (left) allows six molecules of carbon dioxide to combine with six molecules of water to produce one molecule of glucose. Left over in the process are 12 atoms of oxygen. In respiration (right) the opposite process takes place. Glucose combined with oxygen produces carbon dioxide and water. The letters inside the circles stand for carbon, oxygen, and hydrogen. Each circle represents an atom, and each group of atoms is a molecule.

from the soil through the roots and up the stem. With the energy provided by sunlight, the chlorophyll takes *six* molecules of water and *six* molecules of carbon dioxide, breaks them up into their separate atoms, and transfers the hydrogen atoms from the water to the carbon dioxide. Twelve of the oxygen atoms are left over as a waste product, and these the plant breathes out into the air through its stomata. The new molecule thus formed contains six atoms of carbon, 12 atoms of hydrogen, and six atoms of oxygen—$C_6H_{12}O_6$. Its name is glucose, a simple sugar. Enormous numbers of such molecules are produced during every second of sunlight in every chloroplast.

The oxygen which the plant breathes out is very important to men and animals. We breathe it into our lungs. In other words, animals inhale the oxygen which plants exhale.

In the chemical laboratory of the plant many other things go on. Plants cannot live on glucose alone. They must change some of it into cellulose for the stiffening of cell walls, stems, and other parts of the plant body. Some is changed into the kind of sugar we buy in stores. Some is turned into starch and into fat which the plant uses as reserve foods. Sugars, starch, and cellulose are carbohydrates, made up of different combinations of the molecules of carbon and water. Plants also need proteins. These are made by combining carbohydrates with nitrogen and various other minerals such as phosphorus, potassium, iron, calcium, sulfur, and magnesium. The minerals are obtained from the soil.

Respiration in Plants

In order to make cellulose, to build new cells, to store away a reserve food supply, and to carry on all other activities of living and growing, a plant needs *energy*. Energy is obtained by "burning" some of the glucose. Just as coal releases energy by burning in the presence of oxygen, so glucose and oxygen combine to release energy. It is not burning with a flame, such as we see in a furnace, but it is the same chemical process. It is known as *oxidation*, or respiration. It goes on day and night in every cell in the plant. It is just the opposite of photosynthesis.

Oxygen enters the plant through the stomata of the leaves, through the roots (either from air spaces in the soil or in solution in the water), and through the air openings in the stems. When oxygen and glucose combine they form carbon dioxide and water; that is, the glucose is turned back into the same two substances of which it was made. The carbon dioxide and water vapor are sent back into the air through the stomata. During the daytime photosynthesis goes on more actively than respiration and gives off oxygen as a waste product. At night when photosynthesis stops, only oxygen is taken in and carbon dioxide is given off as a waste product.

Certain plants, such as the yeasts, do not live in the air. They get oxygen by taking it from the substances in which they are living. The changes they cause by taking this oxygen are called fermentation (*see* Fermentation; Life; Yeast).

Even the specialists called biochemists still know very little about all these complicated steps in the manufacture and use of plant food. (For further details,

THE PARASITIC DODDER STEALS ITS FOOD

Dodder is a common salmon-colored parasite that twines around the stems of other plants. It contains no chlorophyll so it cannot make its own food. Knobby roots on the dodder stem (right) sink into the tissues of the host plant and suck its life juices.

see Digestion; Enzymes; Food, section "How Different Foods Build Health and Strength"; Respiration.)

The Carbon and Nitrogen Cycles

Plants take in carbon dioxide and use it to build their own bodies. The plants are eaten by men and animals and thus go into the making of human and animal tissue. This tissue is used up in active living. In the process, animals breathe carbon dioxide back into the air, where it is again made available to plants. The exchange is called the *carbon cycle.*

Equally important is the *nitrogen cycle,* for nitrogen is required along with carbon to form the substance of all living cells (*see* Nitrogen; Proteins).

Plants get nitrogen compounds from the soil and unite them with carbohydrates to make proteins. Animals get the nitrogen they need by eating plant proteins. The nitrogen returns to the soil as waste. Bacteria then turn the waste back into simple nitrogen compounds which the plants can use once more.

Effects of Varying Sunlight

Photosynthesis works at its best within certain temperature limits. Below freezing or above 115°F. it either stops or it goes on very slowly.

Different kinds of plants require different amounts of light. A fern thrives in the deep shade of the woods. A cactus needs the brilliant sunshine of the open desert. A little cave-dwelling moss and some algae that live in deep water survive in only the dimmest light.

Length of daylight, called *photoperiodism,* affects the flowering and fruiting stages of plants. This is largely the reason why wild flowers are separated into spring, summer, and fall blooming groups. Skunk cabbage, for example, is one of the earliest blooming spring plants in the northern states. It does not require as long a day as the wild rose which blooms three months later.

How Plants Produce Young Plants

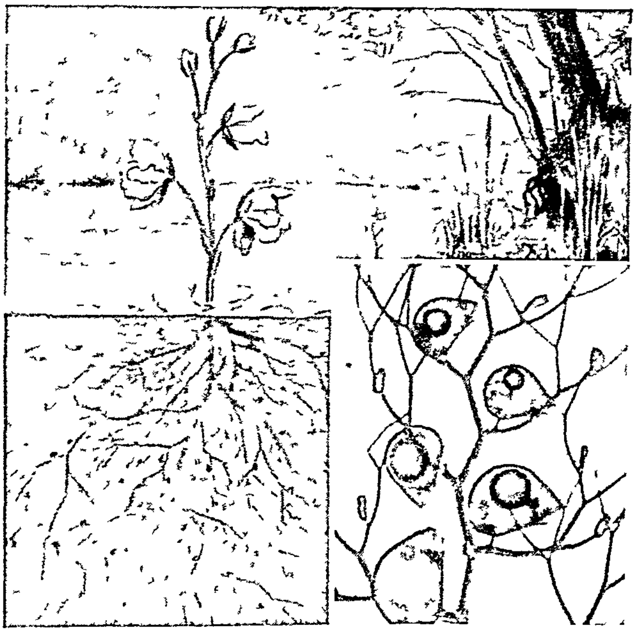
Plants continue to live on earth by producing new plants. The lower forms reproduce *asexually*—meaning without the union of two different sex cells. Bacteria, for example, consist of a single cell or a chain of cells. They usually reproduce by splitting in half. Each half splits in half again, and so on indefinitely. This method is known as *fission* (*see* Bacteria; Cell). Another means of asexual reproduction is *budding.* An outgrowth or bud develops on the parent plant and eventually breaks off to form a new plant (*see* Yeast).

More complex plants reproduce by spores. These are thick-walled cells which grow in spore cases on the parent body. Mushrooms develop spores on the gills underneath the cap. Puffballs are spore cases filled with billions of spores. The brown or black dots on the underside of fern leaflets are spore cases. When the spores are ripe the case opens and the spores drift away on the air. They may grow at once into new individuals or they may enter into a resting stage for months until conditions are right for their development. (*See* Spore.)

The union of male and female cells is known as *sexual* reproduction. Ferns and mosses have the strange habit of reproducing by spores in one generation and by sex cells in the next. Such a process is called "alternation of generations" (*see* Ferns; Moss).

The most highly developed plants are those that make new plants by means of seeds. A seed develops from the union of a male and a female cell. A seed is a complex structure containing a resting young plant and a supply of food to nourish it until it can make its own food. It took millions of years and many changes for plants to develop the process of seed making. First came the plants that carry their seeds on the scales of cones. Pines, cedars, and various other evergreens are naked-seeded plants, or

IT "EATS" WATER CREATURES

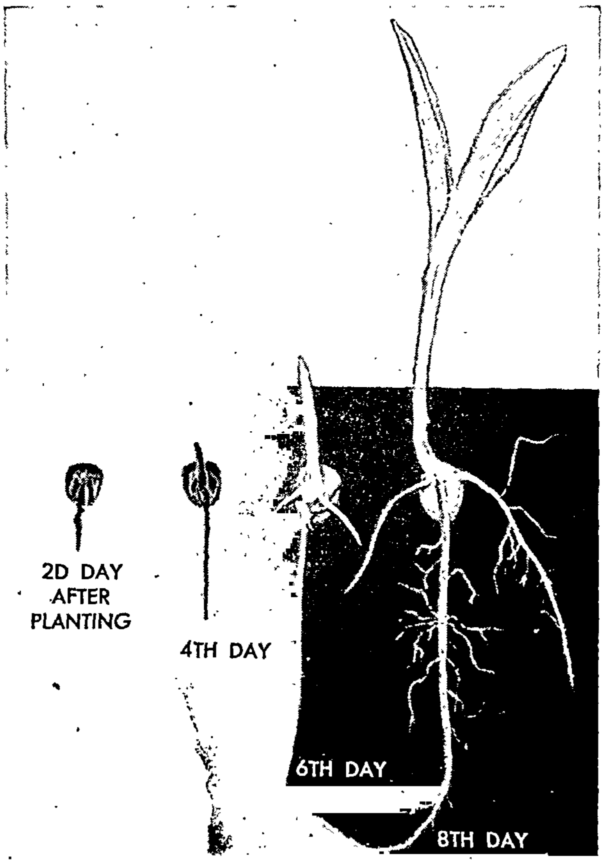


The root pouches of the bladderwort (shown larger in the inset) are shaped *like little jars. They trap* insects whose bodies help to nourish the plant. In flowering time the jars fill with air and float the flowers above the water so that living insects may reach and fertilize them.

THE INSECT TRAPS

The leaves of the pitcher plants capture insects which are drowned at the bottom of the pitcher. The plant digests the insects chiefly for the nitrogen they contain.

THE SPROUTING OF A CORN SEED



Inside the heavy coating of the corn seed is a baby plant, the embryo, together with a single seed leaf and a food supply called the endosperm. When the seed sprouts it has soaked up enough moisture to soften the coating. The growing embryo thrusts out first a root, then the earliest leaf.

gymnosperms. Cones take the place of flowers. Pollen from the male cones is carried by the winds, but most of it is wasted. Only a small amount lodges on the female cones and produces fertile seed.

Far more efficient are the flowering plants. All their brilliant colors, delicate perfumes, and sweet nectar serve seed-making purposes. These are the attractions that draw insect visitors to the flowers. With their furry bodies insects rub pollen off one flower and onto another, thus producing fertile seed with little waste. (The story of seed making is told in the articles on Flowers and on Seeds. For pictures of a sprouting seed, *see also* the article Bean.)

Vegetative Reproduction

Many cultivated garden and vegetable plants reproduce more efficiently from roots, stems, and leaves than from seeds. This is called *vegetative* reproduction. It has the advantage of producing larger plants more rapidly. The potato seed, for example, is very small and develops into a small, weak, slow-growing plant. The tuber, or a fair-sized piece of the tuber, contains a reserve supply of starch and produces a strong, fast-growing plant. Seeds always have some means of traveling away from the parent plant, thus spreading the species far and wide. Vegetative reproduction enables plants to spread quickly over the territory next to the parent plant. Ma weeds are difficult to control for this reason.

Bulbs, corms, rhizomes, or rootstocks, runners, a tubers are all types of stems from which new pla grow (*see* Bulbs, Tubers, and Rootstocks). Man h invented other ways of producing new plants. *Cu tings*, also called *slips*, are twigs, branches, or lea cut from the parent plant and placed in soil, sa or water. In time new roots, stems, and lea grow from the cuttings. The willow tree, the gera ium, and begonia and African violet are e amples of plants that may be produced in this wa A process called *layering* is used with certain tre and shrubs. When a branch is bent down to tou the soil it sends roots into the ground and a ne plant results. Gooseberries, blackberries, grapevine forsythia and other shrubs may be grown in th way (*see* Grapes).

Improved varieties of fruit are obtained by *gra ing*. The stem of one plant which produces fine fru (the *scion*) is made to grow on the stem of anoth plant (the *stock*) of hardy, but inferior quality. Th stems are cut so that the cambium layers of the tw are in contact and grow together. The cuts are the tied together and covered with cloth or with a speci wax. *Budding* is the process of removing a bud fro one plant and setting it into the bark of anothe usually a young seedling.

Behavior of Plants

All living things respond to the world about them Since most plants are rooted to the soil, they can not move freely. They respond to a stimulus by bend ing, twisting, and growing in certain directions. Suc movements are called *tropisms*. The word comes fro the Greek word *trope*, meaning "a turning." So tropism is a turning in response to a stimulus. I may be positive (turning toward the stimulus) o negative (turning away from the stimulus).

A common tropism easily observed in house plant placed on a window sill is "light turning" (*photot ropism*), or "sun turning" (*heliotropism*). The leave bend and the stem tips toward the window and th light. A stem tends to thicken on the light side an lengthen on the dark side because of the differen rates at which photosynthesis is taking place. Thi lengthening bends the stem toward the light.

When a seed germinates, the part that is to produc stem and leaves always grows upward and the roo downward. This behavior illustrates two types o *geotropism*, the responses of a plant to the pull o gravity. *Hydrotropism* causes roots to turn in th direction of moisture. Response to touch (*thigmotro pism*) explains why the leaves of a sensitive plan droop at a touch. It also explains why the tendrils of vines twine around or cling to their support.

Roots respond to minerals in the soil. This is a form of *chemotropism*, or "chemical turning." Anothe example is provided by the reproduction of ferns The egg cells, which lie on the ground, secrete an acid which acts upon the free-swimming male cells and draws them in by *chemotropism*.

Tropisms are caused by growth-promoting hormones called *auxins*, which are produced in the cells in response to the stimulus. (For details, *see* the subheading "Auxins for Growth" in the second section of this article.)

Meeting Special Problems

In extremely dry climates plants have special ways of absorbing and storing water. Some desert plants produce a stronger sap than normal. Thus, by means of osmosis, they can absorb water more powerfully. Others, such as the cactus, have large cell cavities for storing water. Some of these plants have lost their leaves through which water might evaporate. Thorns take the place of leaves. This prevents animals from chewing holes in the stems and letting the stored water escape. Food making is carried on by means of the chlorophyll in the green stems. Some desert plants have met the problem of water supply by confining their active life to the short rainy season. They spend the remainder of the year in a half-dried, resting state.

A PUFFBALL SHOOTING SPORES

A puffball is a fungus. The part above ground is the spore case. When it is ripe, the thin shell bursts at a touch and shoots out billions of spores.

We have seen that nitrogen is one of the important food elements of plants. They cannot absorb it in its pure state, but must get it in the form of nitrates from the soil (*see* Fertilizers; Nitrogen). Wild plants often live in places where nitrates are scarce. Swamps and bogs are particularly lacking in this respect. To supply the deficiency, certain "carnivorous" plants have the ability to catch and eat insects whose bodies are rich in nitrogen compounds. (*See* Pitcher Plants; Venus's Flytrap; Sundew.)

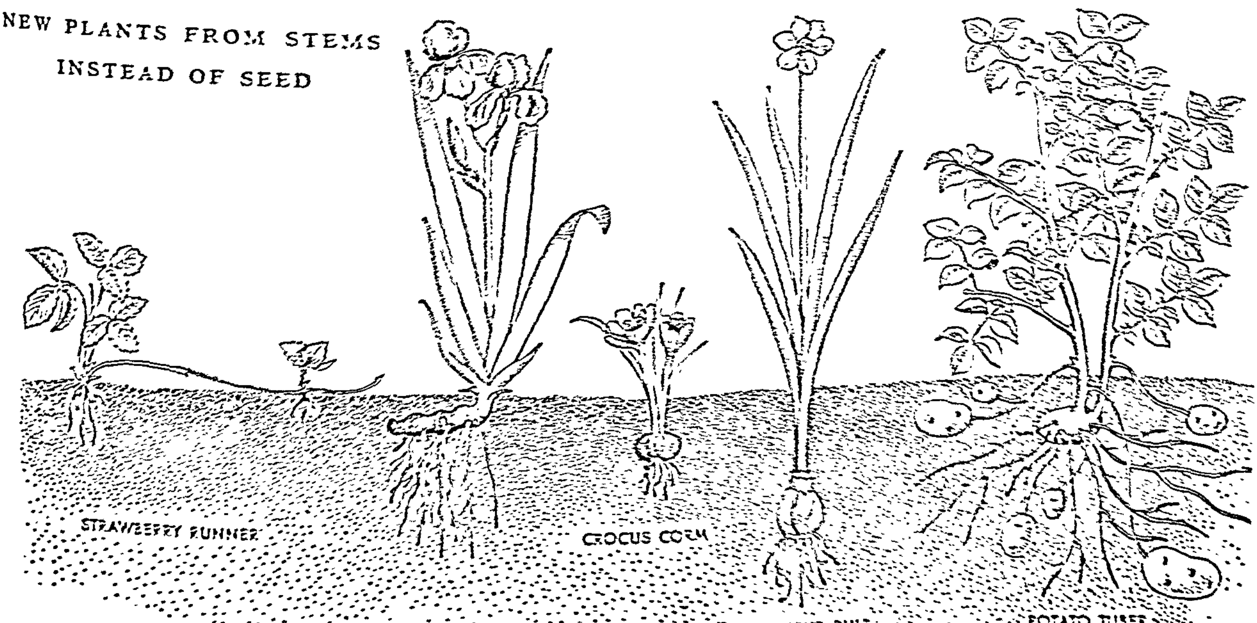
Certain forms of bacteria have the power of forming nitrates out of pure nitrogen taken from the air. The members of the pea family and other legumes have formed an alliance with such bacteria. The bacteria colonize on the roots of the plants, providing a constant and plentiful nitrate supply (*see* Alfalfa; Bacteria). In return, the legume supplies the bacteria with the carbon-made foods they are unable to manufacture for themselves. This is a good example of one of the many forms of natural partnerships in the plant and animal world, which scientists call *symbiosis* ("life together").

How Plants Spend the Winter

During the summer plants manufacture and store food in roots, stems, or seeds. In the winter the plant rests. There are various ways of spending the winter. Plants that live only a single season are called *annuals*. They flower the same season they are planted. Then, throwing all their strength and reserve food into their seeds, they wither and die. Inside its protective covering the embryo plant waits for the moisture and warmth of spring to start growing.

Biennials make only leaves and buds the first season and store up food in their underground roots.

NEW PLANTS FROM STEMS INSTEAD OF SEED



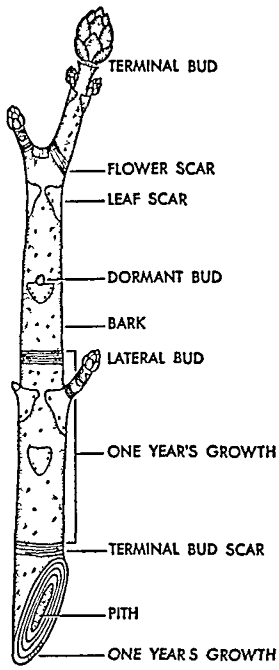
Some plants produce stronger, faster-growing new plants from their stems than from seed. The runner is a horizontal stem above ground. New plants grow from the nodes, or joints. The rhizome, or rootstock, is a horizontal stem under ground. The corm is a solid, thick, bulb-shaped stem. The bulb is a cluster of scalelike leaves growing from the tip of a small underground stem. The tuber is an underground stem enlarged with stored starch. New plants grow from the eyes or buds.

The upper parts die in the winter. Examples are the beets, turnips, parsnips, carrots, and many common flowers. The next season the reserve food from the root part is used to make new stems, which bear flowers and seeds. The second winter the plant dies and its seeds produce the new generation in the spring.

Many biennial plants lose their stems and upper leaves but keep green basal leaves all winter. The leaves grow in beautifully patterned rosettes. They lie flat on the ground, spread out around an underground taproot. Possibly the function of such rosettes is to carry an abundant water supply to the root. The leaves are slightly grooved, and rain water pours from the outside and top of the cluster to the center and so down to the root.

Most wild plants are *perennials.* They go on living from year to year. In cold climates they store food in root or stem and rest in the winter. In warm climates they simply go on growing. Trees and shrubs are typical perennials. They shed their leaves and store the next year's growth parts inside buds protected with a jacket of varnished scales. They look dead in the winter, but they are very much alive, as one may learn by opening the buds. As the hours of daylight grow shorter and the nights grow longer and colder, the foodstuffs in the leaves drain back into the twigs, branches, and trunk. The chlorophyll breaks down chemically and becomes colorless. It is then that the leaves show their autumn colors of yellow, red, and orange. These colors have been present in the leaves all the time, but there is so much more of the green material that it covers up the other colors.

A HORSE CHESTNUT TWIG

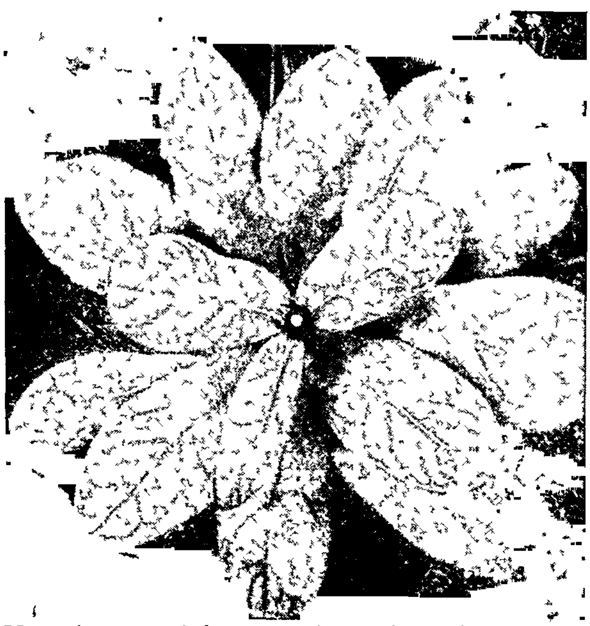


Trees and shrubs lose their leaves in the winter. The buds rest inside waxy overlapping scales. The buds develop into flowers and leaves in the spring.

While the color changes go on, a thick, corky skin called a separation layer grows between the stem of the leaf and the branch on which it is growing. After this cork layer is formed, it splits apart. One half goes with the leaf, the other half covers the scar on the branch and seals it against insects and loss of moisture. Thus the leaves drop off. Oak leaves do not fall until very late because the separation layers are not perfectly formed. In tropical countries, where there is a change from wet to dry seasons, many trees drop their leaves in the dry season. This prevents them from losing moisture through evaporation.

The winter study of twigs is interesting. One can learn to identify trees and shrubs by their twigs alone, for no two kinds have exactly the same arrangement of buds and leaf scars. The buds are tiny, living plant parts which develop into leaves or flower clusters. They are covered with overlapping, waxy bud scales. At the top of the stem is the terminal bud. The stem grows in length from the terminal bud. It may or may not produce flowers. Lateral buds grow at the sides of the stem. New branches grow from the lateral buds.

A WINTER ROSETTE



Many plants lose their stems and upper leaves in the winter but keep green basal leaves all winter. This rattlesnake weed is an example of the beautiful rosettes formed by such leaves.

Bud scales are modified leaves. In the spring, as they expand with warmth and rain, they may take on soft colors, such as the yellow and rose of the hickory and horse chestnut. The scales of sumac do not fall off but develop into true leaves. The colored "petals" of the flowering dogwood are not petals at all but the expanded scales of the bud. The true flower is a small cluster inside the "bract," as this type of leaf is called.

Experiments for Home and School

Here and on the following pages are experiments that may be made at home or in the schoolroom to illustrate some of the principles of plant life. In most cases bean and radish seeds are suggested because they sprout and grow rapidly. A few glasses, large glass jars, plates, paper napkins and blotters, sand, and good rich earth are the chief supplies necessary.

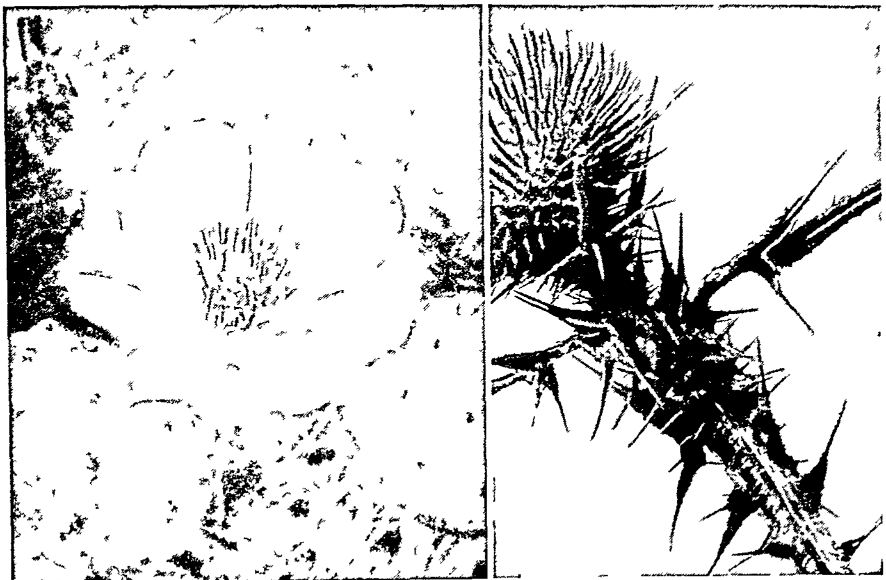
You can watch seeds sprout and observe various processes by the following method: Line a water glass or glass jar with a wet paper towel. Put a little water in the bottom so the paper will stay moist. One might line the jar with a blotter and fill the center of the glass with moist moss. Soak

the seeds overnight to soften the seed coat, then place the seeds between the wet paper and the glass. They will stick to the glass, and you can see what happens.

Experiments with Seeds

1. To study the structure of the two kinds of seeds, soak a bean seed (dicotyledon) and a corn seed (monocotyledon) overnight. Inside the bean seed are two plump seed leaves, the cotyledons. They store enough food to last the young plant until it is able to put forth green leaves and make its own food. Attached to these is the embryo plant. It has a small root and the first leaves lying between the two seed leaves. The corn embryo has one seed leaf. Food is stored in the endosperm, outside the embryo.

ANIMALS STAY AWAY FROM THESE

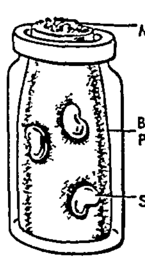


The prickly pear cactus (left) stores water in its thick, fleshy stems. The leaves have been reduced to small thorns, which protect the plant from grazing animals. Many other plants are provided with thorny armor. No animal cares to come in contact with the thistle (right), and even humans seldom try to pick its beautiful flowers.

2. A young plant cannot grow without the food stored in the seed leaves. Place in the blotter-lined glass one whole bean seed; one with one seed leaf removed; one with only half a seed leaf. Place in a dark place and observe the development of the plant.

3. Cotyledons contain food in the form of starch. Make a weak iodine solution by putting a dropperful of iodine into half a glass of water. Drop some of the weak iodine on a soaked bean seed. If it turns blue you have proved that starch is present.

4. The outer coating of a seed must be softened with water before the embryo plant can break through.



Try to sprout some seeds without soaking them. Weigh a handful of dry bean seeds. Weigh them again after soaking them in water for 12 hours. What is the percentage of increase?

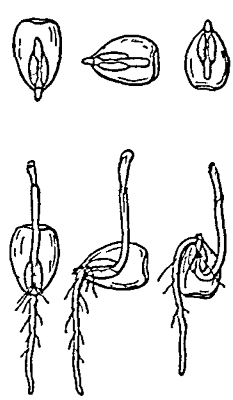
5. Seeds need a moderate temperature. Place seeds in three glass jars. Put one jar in the refrigerator; one beside a hot radiator; one in a room at 65° to 70° F. Observe which ones develop best.

6. Seeds need air (oxygen). Place seeds in three glass jars. Leave one in the open air and keep moist; cover one jar with a tight lid; place a lighted candle in the third jar and cover tightly (the candle will burn until the oxygen is exhausted). The seeds will not sprout in the jar from which all oxygen is exhausted.

7. The part of the embryo that is to become the root always grows down; the part that is to become the stem and leaves always grows up. Place corn seeds in jar with pointed end down; pointed end up; pointed end sideways. When the seeds sprout, they will look like they do in the picture at the right.

8. Plants need light. Seeds will sprout in the dark, using the food stored in their seed leaves. After they have sprouted, however, they need light to develop into healthy plants. Plant the same kind of seeds in two pots with the same kind of soil. Keep one in a dark closet. Place the other in a brightly lighted window. Compare the two after a week or two.

9. Farmers make germination tests to find out what proportion of seeds will develop into healthy plants. To test viability (ability to live) of seeds place 100 soaked seeds between layers of wet blotters or in moist sawdust. As the seeds sprout, remove them. Do this until no more sprout; then count the remainder. If there are eight, 92 per cent germinated. According to the United States Department of Agriculture, the following percentages of germination are considered good for first-class seeds: corn, 92 per cent within five days; oats, 93 per cent within three days; alfalfa, 90 per cent within six days.

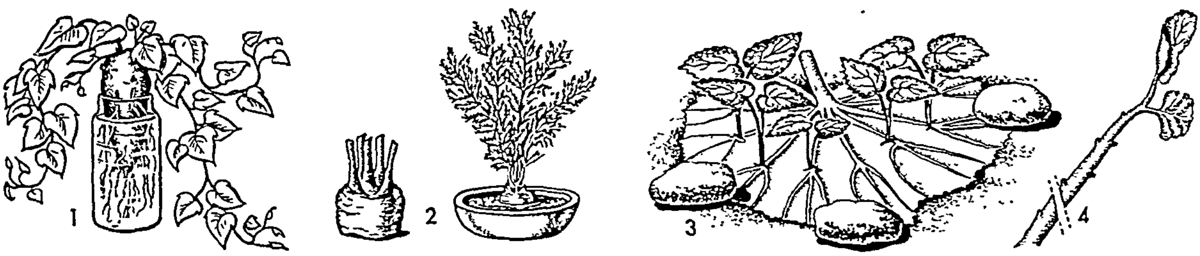


Experiments with Leaves

1. Leaves contain chlorophyll. Cover fresh green leaves with boiling water for several minutes; then place them in rubbing alcohol to remove the green color. The liquid will be a clear green; the leaves will be bleached.

2. Drop iodine on the bleached leaves. They will turn blue, showing that starch is present. The test will not work well if the leaves are picked early in the morning. This shows that the leaves did not manufacture food during the night, and whatever starch was present the day before moved to other parts of the plant during the night.

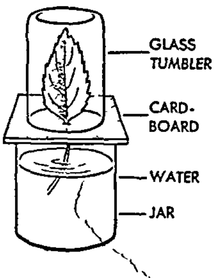
GROWING NEW PLANTS WITHOUT SEEDS



1. Place a sweet potato narrow end down in a jar of water. Keep it in the dark until stems have begun to grow; then put it in a sunny window. The potato will become covered with purple-veined leaves. 2. Cut off two inches of carrot at the big end. Set it in a shallow bowl of water with pebbles to hold it in place. Feathery leaves will grow out of the top. 3. Peg down a large, thick rex begonia leaf on damp sand. Slit the big veins. Small plants will grow from the slits. 4. To prepare a geranium cutting make a slanting cut through the stem just below a leaf. Remove all but two or three of the top leaves.

3. Cut two thin circles of cork from a bottle cork, and with a pin stuck through them fasten the pieces on both sides of a growing leaf. After two weeks remove the corks and observe the area which has been covered. It will have lost its green color. The covered part will also fail to color blue when tested with iodine, showing that no starch is present.

4. Leaves turn toward light. Place a potted plant in the window and let it remain in the same position for two weeks. Observe how leaves and stem turn to the light. Then turn the plant around and observe how the leaves turn after a few days. To keep house plants shapely one should turn them daily.



5. Leaves give off water. Punch a hole through a piece of cardboard, slip the stem of a leaf through the hole, and set the stem in a glass of water with the cardboard lying across the top of the glass. Put another glass upside down over the leaf and resting on the top of the cardboard. After a few hours moisture will gather on the inside of the inverted glass, showing that water from the lower glass has passed through the leaf stem and out through the stomata of the leaf.

This experiment may be done with a plant growing in a pot. Moisten it well. Then fasten cellophane or wax paper around the entire pot and tie it around the stem of the plant. This will keep water from the pot and the soil inside the paper. Then set a glass jar over the pot. Water evaporating from the leaves will collect on the glass.

Experiments with Stems and Roots

1. Stems always grow up. Plant some radish seeds and let them grow in the dark until the stems are rather long. Then turn the jar over on its side. In 24 hours or so the stems will have turned at right angles and will again be growing up. Now turn the jar to the original position. Again the stems will grow upward, and the radish plant will have a stem with two right angle turns in it.

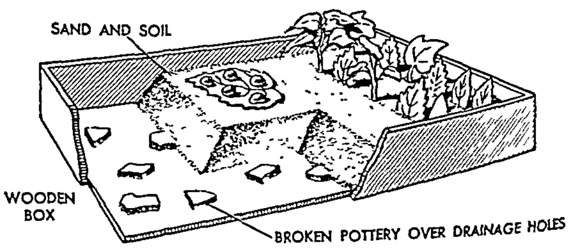
2. Vascular bundles in stems carry water. Freshen a stalk of celery by standing it in ice water for an hour. Then place it in water colored with red ink and set it in bright light. When the leaves turn pink, scrape off the outer layers of the stalk until you come to red lines. These are the vascular bundles colored with red ink from the water glass. At the base of the stalk you will see the bundles as red dots. Split the stem of a white carnation. Put one part of the split stem in a glass of green-colored water, the other part in a glass of water colored red. The flower will turn green and red.

3. Roots need water and air. Fill three pots with the same kind of soil and plant the same kind of seeds in them. Place them on the same windowsill. Keep one plant moist and the soil loose; keep one dry and the soil hard-packed; keep the third flooded with water. Observe which plant grows the best. The roots in the flooded pot and in the dry hard-packed pot do not get enough oxygen.

4. Roots need minerals. Plant the same kind of seeds in four pots. Fill one pot with rich wood humus or with good potting earth from a greenhouse; one with the hard soil that may be found near building excavations; one with clean sand; and one with sawdust. Give each plant the same amount of moisture and sunlight. Allow several weeks for the observation.

Growing New Plants without Seeds

The drawings on this page show some of the plants that may be grown from leaf, stem, or root. Plants started in this way are easily killed by drying, so it is advisable to keep them in a covered case, or terrar-



ium. These are simply wooden boxes with glass sides and top. (For drawings and explanations of how to build a terrarium, *see* Nature Study.) A wooden flat is also useful for growing plants from vegetative parts. After the plants have taken root they may be moved into a pot where they will have more room to grow.

Pussy willow and forsythia stems, kept in a jar of water, will grow new roots near the bottom of the stem. After the roots are well formed, the stems may be planted in soil. New African violet plants may be grown from the leaves. Cut off a leaf with a bit of stem and stand it upright with the stem buried in damp sand. Cover it with a glass jar so it will remain moist and warm. Two-inch long pieces of the snake plant (sansevieria) leaf will grow in the same way. Simply stand the pieces upright, half buried in damp sand, and cover with glass.

(For a Reference-Outline and a classification of plants, *see* Botany. *See also* **Plants** in the FACT-INDEX at the end of this volume.)

What Men Do with Plants

The Many Uses of Plants

OF ALL LIVING creatures, men are the most lavish users of plants. Lower animals merely eat plants or use them for shelter. Men do the same, but they also make plants serve them in countless other ways. Here are the main ways in which plants help us.

We eat plants. The chief use men make of plants is for food. In North America the most important food plants are the cereal grains, named for Ceres, the Roman goddess of agriculture. The saying "Corn is king" is due to the tremendous amount of this grain raised for feeding men and animals and for many industrial purposes. Next in quantity is wheat. Other great cereal crops are oats, rice, barley, rye, and buckwheat. The crops of vegetables and fruits are also large and diversified, giving the people of North America a greater variety of food than is enjoyed by the people of any other region in the world. (*See* Reference-Outline with the article Agriculture.)

Food plants raised in other parts of the world come to North America in fleets of ships. We get bananas from Central and South America, coconut oil from the islands of the South Pacific, dates from Iraq, and a host of plant delicacies from other regions.

Many plant foods are processed; that is, manufactured into purer forms. Sugar, flour, and the vegetable oils are examples of processed foods. Canning is another form of processing (*see* Food Preservation).

We drink plants. Water blends tastily with the flavors produced in the cells of plants. Many of these beverages are ready-mixed by nature; coconut milk, apple cider, citrus and grape juices, nectars of apricots and other fruits, are examples. Other drinks, such as coffee, cocoa, and tea, are prepared by steeping plant substances in hot water. Still others come from processed plants, as the "cola" drinks from the kola nut of tropical America. Many of our "soft" drinks are mixtures of some plant juice for flavor, sugar for sweetness, and carbonated water to make the "fizz." The "hard" drinks contain alcohol, fermented from any sweet or starchy plant through the agency of other plants, the yeasts.

We wear plants. Cotton is the chief plant used for clothing. From the flax plant we make our linen. The rayons, artificial fibers that resemble silk, are manufactured from wood or cotton fibers (*see* Rayon). A century ago plants furnished most of the dyestuffs with which cloth was colored, but today nearly all these dyes are manufactured from coal tar.

We are sheltered by plants. Shelter in North America is typically provided by a plant product—wood. In this region there are more walls of wood than of brick or stone, more roofs of wood than of slate or tile, more floors of wood than of cement, steel, or bare earth. Within the home, the furniture and the conveniences of living are chiefly of wood or plant-fiber cloth. The wall covering is usually paper; the paints are dried films of linseed oil; and the linoleum is a mixture of linseed oil and cork.

We take plants as medicines. By experimenting throughout the ages men found that certain plants would relieve their aches and pains. Boneset, catnip, horehound, pennyroyal, sage, and other such plants used to be dried in attics and over fireplaces for home use. They were called "simples" many years ago. From these "simples" the village doctor made mixtures which he called "compounds." Today we call them *drugs*, an Anglo-Saxon word for "dry," although many are pastes or liquids (*see* Drugs). Many of these plant drugs are mild and safe to take without a doctor's advice, but others are violent poisons (*see* Poisonous Plants).

The chief drug plants of North America are boneset, cascara sagrada, ginseng, golden seal, hellebore, hepatica, mullein, pennyroyal, white pine, pleurisy root, sarsaparilla, senna, witch hazel. From Peru comes quinine; from Formosa, camphor; from China, opium; from India, nux vomica; and from Europe, belladonna.

We read, write, and wrap with plants. The people of North America use more than half of all the world's paper. One day's issue of their newspapers requires spruce trees cut from hundreds of forest acres in the northern regions. One day's wrapping and sacking of purchased goods requires pine trees cut from hundreds of acres in the southern regions, where kraft paper is manufactured. Even the better papers, for books and letters, are mixtures of wood pulp and linen fiber. A surprising amount of paper is made into cardboard, roofing paper, insulation for electric wires, and filters for air-conditioning (*see* Paper).

We burn plants for fuel. Wood continues to be the most convenient fuel for many homes. Charcoal, a wood product, is also a favorite for special types of burners, such as are carried on picnics. It must not be forgotten, either, that coal was formed from plants that grew long ago. (*See* Charcoal; Coal.)

We play with plants. Can you name a game that does not use wood in some form? Think of tennis rackets, baseball bats, croquet mallets, bows and arrows. Basketball is played on wooden floors and football has wooden goal posts. If "playing" is extended

to refer to music, we recall that stringed instruments, wood winds, and drums are largely wood.

We manufacture from plants. Wood was the first raw material men used in handicrafts. From it they carved rough tools and weapons, they attached shafts of it to stone spearpoints and arrowheads, and they bent it into bows. Today wood is employed in a host of useful forms of every type from telegraph poles to toothpicks, and from railway trestles to kite frames. From wood men make boats, vehicles, and airplanes.

Trees that yield some special products are numerous, read, for examples, the articles on Chewing Gum, Cork, Rubber, and Turpentine Many food crops have important uses in factories; from corn come industrial starches, gums, glues, oil (*see* Corn). A useful plastic is made from soybeans, others are made from cotton. Most perfumes were originally made from plants, although today's chemists are clever at producing imitations (*see* Perfumes). The list of useful products made from plants might be expanded indefinitely.

Agriculture—a Supply of Economic Plants

Those plants which men have found useful are called *economic plants.* Out of several hundred thousand different kinds of plants, only about 200 different kinds are eaten; out of fully 1,500 different plant fibers that men have tested, only about 20 can be made into comfortable clothing. But men do not limit the list of economic plants merely to those that furnish the necessities and conveniences of daily life. They extend the list to include the trees, shrubs, and grasses that help to make pleasant surroundings, and they consider "economic" even the colorful and scented beauties of the gardens, worth so little to those who do not love flowers, and so much to those who do

THE "CHOCOLATE TREE" STAYS IN THE TROPICS

A native of tropical America, the cacao tree has been transplanted to other hot, moist lands. But other regions must import the beans from which chocolate and cocoa are made.

The Beginnings of Agriculture

How did agriculture begin? Back in the very ancient past, the fruits, nuts, and berries of the forests and thickets provided food. Later, men learned to dig roots and scrape or pound them to a paste for eating Still later the idea of cooking this paste, and certain juicy stems and leaves, came from campfire experiments Men found that not every plant may be eaten, some tasted bitter, and others had unpleasant effects after they were swallowed.

It probably did not take ancient men long to learn that certain barks, slender stems, and vines could be twisted together into cords for fishing, for tying captured animals, and for making baskets Slowly came the practise of spinning threads and weaving cloth from these wild fibers. The distaff and the loom were among the first inventions.

As the centuries passed, the more clever tribes selected certain wild plants for taming, and began the practise of *husbandry,* which means "keeping near the house" in the old Anglo-Saxon language. No longer was it necessary to roam far and wide to find food Thus began one of the chief occupations of men—agriculture. Seeds from plants pleasant and safe to eat were planted, their young growth protected from weeds, and methods of storing harvests through the winter were devised.

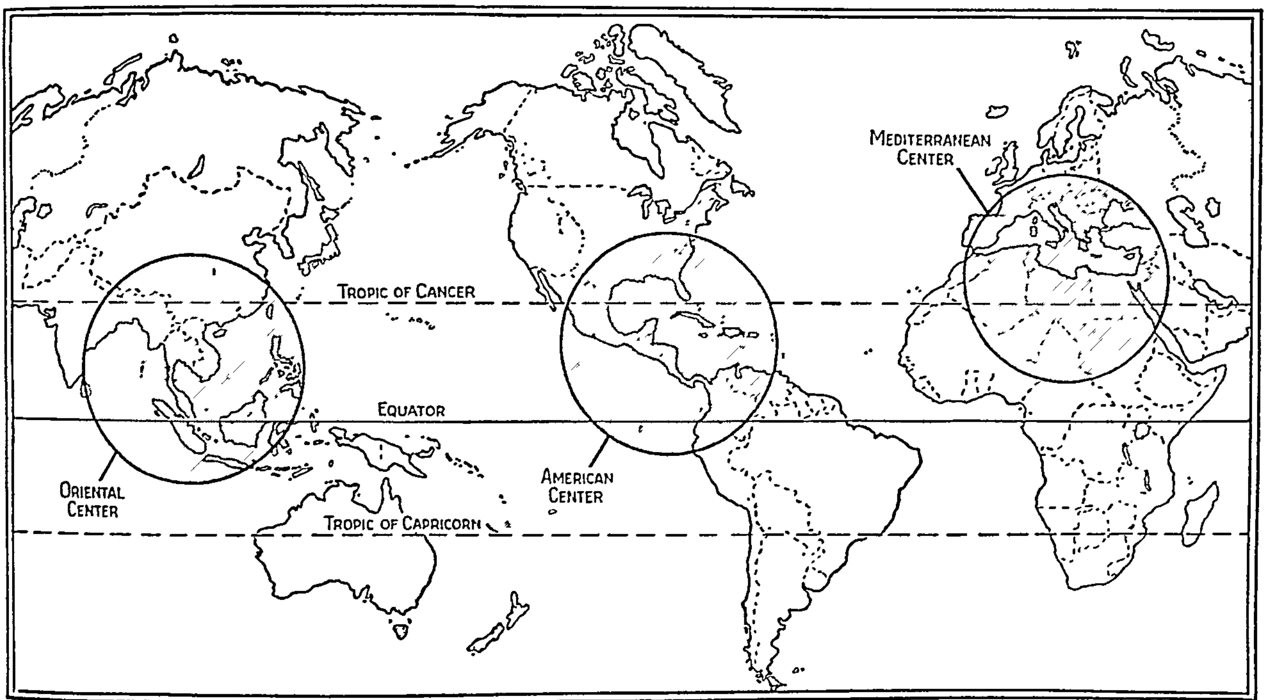
Agriculture—and civilization along with it—developed from three distinct centers of the world: the Mediterranean, the American, the Oriental

The Mediterranean center included those shores where the three great continents—Africa, Asia, Europe—meet Up to two or three centuries ago the Mediterranean peoples planted more different kinds of food than did the dwellers in any other part of the world. They also raised textile fibers Among their crops were apples, carrots, celery, chestnuts, coffee, cotton, dates, figs, flax, lemons, lettuce, mustard, olives, onions, peas, plums, sugar cane, turnips, walnuts, wheat.

The American center included the narrow region of Central America, and the wider lands to the north (now Mexico) and south (now Colombia-Venezuela) In these lands men learned how to raise cacao (chocolate), corn (maize), cotton, kidney and lima beans peanuts, pineapples, potatoes (sweet and white), pumpkins, squash, tomatoes, and vanilla.

The Oriental center included all of eastern China, Indo-China, Malaya, Japan, Korea, and the Pacific

THE ORIGINAL HOMES OF MOST OF OUR DOMESTIC PLANTS



We do not know where the wild ancestors of many of our useful plants were first discovered. But the map shows where most of these plants were first cultivated as staple crops. From these centers they were carried to other lands. The text on the preceding page tells which plants came from each of the great centers. Some, like cotton, were developed in all three.

Islands. In these regions men of ancient times grew cotton, oranges, peaches, rice, soy beans, tea, yams, and a few others. The Orient has lacked variety in its foods from the earliest times to the present.

Most of the plants that a few centuries ago were grown in only a single part of the world are now cultivated in any place where climate and soil permit. There is also much traffic in foods and fibers across continents and even oceans—from places of favorable growing to the crowded centers where there are many to be fed and clothed.

Plant Hunters and Their Work

When white men first came to the land that is now the eastern coast of the United States, only a few of the 80 chief crops now raised were to be found. The Indians were cultivating, after a fashion, small areas of beans, crab apples, corn, pecans, pumpkins, raspberries, squash, sweet potatoes, and tobacco. Tomatoes were also grown, but the white man feared to eat them. New settlers from Europe usually brought seeds of their own favorite crops, and found that nearly all of them would thrive in the New World. Most of the grains except corn, most of the garden vegetables, and many of the fruits were newcomers to America as truly as were the colonists.

In 1827 President John Quincy Adams instructed the United States consuls to send home any seeds and plants that might become useful crops in North America. Later administrations expanded this service, and today the Division of Foreign Plant Introduction of the Department of Agriculture sends its specialists all over the world seeking for new plants or better varieties of plants. The experiences of these "plant hunters" in the wildest parts of Asia, Africa, and South America are tales of adventure as thrilling as those told by seekers after gold or wild animals. Although the expenses of these experts may be only $200,000 a year, the value of their discoveries may be worth $100,000,000 a year to American farmers. Improved strains of durum wheat from Russia, barley from Turkey, drought-resistant grasses from India, and soy beans from Manchuria are typical of the better crops made possible by the plant explorers. (*See also* Agriculture.)

Chemurgy Finds New Ways to Use Plants

In 1935 the first Farm Chemurgic Council was held at Dearborn, Mich., and one or more meetings each year have followed. The word chemurgy (*kĕm'ûr-jĭ*) means "chemistry at work." The council included three groups of experts—in agriculture, in industry, and in science. The latter were chiefly chemists. The chief purpose of the Chemurgic Councils has been to devise non-food uses for farm products. Chemists, especially, have found ways for manufacturers to use more of the crops that farmers raise. The most important chemurgic principles are these:

1. Surplus food crops should be used in manufactures. Many farm crops are often grown in greater quantities than can be eaten. Studies on the use of soybean oil for paints and lacquers, and soybean meal for plastics, are examples of chemurgic projects.

2. Land that is too poor, too wet, too dry, or otherwise unsuitable for food crops may raise other plants profitably. One of the leaders of the Chemurgic Council, Dr. Charles H. Herty of Georgia, by experiments in his laboratory at Savannah found ways to make news-

print from the pines of southern forests. These had been considered too full of resin for the manufacture of any paper other than kraft—brown wrapping paper. His discoveries resulted in new, large newsprint mills near the Gulf Coast, where pine trees grow rapidly.

LEADER IN CHEMURGY

Charles H. Herty gave the South a new industry by finding how to make paper from slash pine wood. He is shown putting a log into a pulping machine.

3. Plant wastes should be turned into profitable materials. Industrial alcohol may be fermented from sugar-cane tops, poorly shaped fruits, undersized potatoes, and many other "culls" unsuited for sale as food. A blend of this alcohol with gasoline has been successfully marketed as a motor fuel in several states. Scrap lumber, limbs, slabs, and other waste wood are chipped, steamed under great pressure, then exploded into a fluffy mass called lignocellulose; this is compressed into boards and panels that take the place of lumber. The largest mill making this product is in Laurel, Miss. Wheat straw, formerly waste, now goes into such products as cardboard cartons, egg cases, and tablet backs. The straw from seed flax used to be considered worthless. Then chemists and engineers devised a cheap process for separating the fiber from the straw and a way to make cigarette paper from the fiber. Until that time the United States had imported its cigarette paper from France, where it was made from linen rags.

4. Certain small crops should have more uses. The Jerusalem artichoke of the midwestern states—a sunflower—has a starchy root that was prized as food by the Indians but despised by the white settlers. It is an excellent source of industrial alcohol. Castor oil has been converted by chemical treatment into a satisfactory drying oil for varnishes and lacquers.

5. Certain crops should be planted in North America to provide raw materials now imported from Africa, Asia, and Europe. Textile starch, used on all cotton threads, is being made from Mississippi sweet potatoes to supplant starch shipped from Java. Tung oil is pressed from the nuts of tung trees that grow well along the Gulf Coast, taking the place of some of the tung oil shipped from China. Peanut hulls prove satisfactory as insulation for refrigerators, replacing cork imported from Spain.

A pioneer chemurgist was the noted Negro chemist, George Washington Carver of Tuskegee Institute. He prepared nearly 200 different products from peanuts, more than 100 from sweet potatoes, and scores of paints, inks, greases, medicines, and other useful things from common farm plants. His ideas of non-food uses for farm crops are the foundation of chemurgy.

How Diseases of Plants Are Cured or Prevented

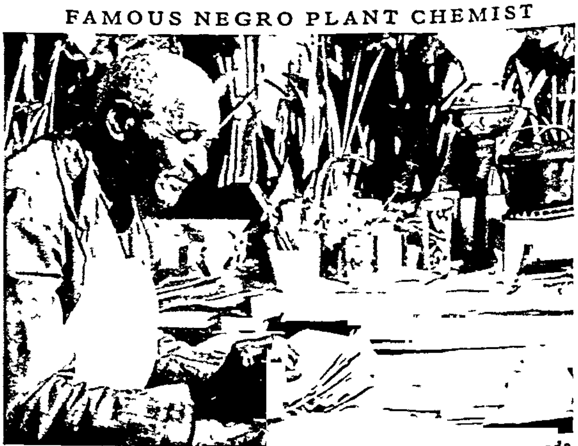
Plants, Like Animals and people, have their ailments, and wither or die even when they have sunshine and rain. There are five chief causes of sickness in plants; for each, gardeners and farmers have remedies that are more or less efficient.

Fungus diseases of plants are very common. The fungi usually dwell as parasites upon the plants, sending tiny root-threads into their tissues (*see* Fungi; Parasites). Although there are dignified scientific terms for the fungus diseases, these infections are commonly known by descriptive names such as blight, mildew, mold, rot, rust, scab, smut, spot, and wilt. The fungi can be killed by steeping the seeds in antiseptics (as formaldehyde), or spraying the plants with compounds of arsenic, copper, lead, and some other metals (*see* Spraying).

Virus diseases of plants spread more rapidly than any others. They cause tremendous damage. At one time Californians abandoned 10,000 acres where they had been growing sugar beets because "curly top" virus disease made raising this crop unprofitable. Loss due to the virus disease called tobacco mosaic runs into millions of pounds of tobacco each year in the United States alone.

The "mosaic" group of virus diseases is the largest. These produce a mosaiclike mottling on the foliage. "Ringspot" virus diseases produce circular spots. In the "yellows," the green parts lose color, and many slender, erect, out-of-place shoots appear. Some viruses produce galls, others make the leaves roll or curl, and others prevent full growth. Feeding insects, particularly leaf hoppers and aphids,

FAMOUS NEGRO PLANT CHEMIST



In his simple laboratory, working mostly with home-made equipment, George Washington Carver discovered how to make hundreds of new products from the peanut and the sweet potato.

are the carriers which spread most plant viruses. It is extremely difficult to control these insects completely enough to keep them from spreading virus infection. The most promising method of fighting virus diseases lies in developing disease-resistant strains of plants through hybridization. Burning infected parts of crops helps.

Soil deficiencies may cause diseases of plants. Certain minerals that the roots gather for food are needed in large amounts, others in very small amounts. The lack of any necessary chemical element in the soil will prevent the healthy growth of the plant. For example, if leaves show a pallor, called *chlorosis*, it may be due to a need for the extremely small quantity of iron necessary to form green chlorophyll. Soil deficiencies in the chief mineral foods of plants are usually supplied by fertilizers, but it is not always easy to determine which of the minerals needed in very small amounts may be missing. (*See* Fertilizers; Soil.)

Insect eggs and larvae damage plants. Laid on or under the bark, on the leaves, or elsewhere, the eggs hatch into larvae which eat up the leaves or bore into the wood (*see* Insects). In other instances, diseases termed galls and scales are produced (*see* Scale Insects). Treatment for insect pests usually involves spraying, although in some instances a harmless insect that feeds upon the harmful one can be found. (*See* Ichneumon Flies; Ladybug.)

Plants are wounded by storms, animals, and men. Everyone has seen some great gash cut into the bark of a tree, reaching to the living wood beneath. The best aid men can give to valuable plants is to paint the wounds with some antiseptic, and protect them from further injury by wrapping. (*See* Tree Surgery.)

Self-Healing of Plants

It is often said of human diseases: "Nature is the best physician." This is also true of plant diseases. The corky layer that soon covers the wounds of a healthy tree is a perfect cure. It has been indicated by some experiments on corn that plants may develop in their tissues a *bacteriophage* or "germ killer" similar in effect at least to the antitoxins that develop in the blood of animals (*see* Bacteria).

Another lesson learned by humans for the protection of their own health may also be applied to plants: those with a strong constitution resist diseases to which the weak succumb. Good food from rich soil makes healthy plants, as a rule.

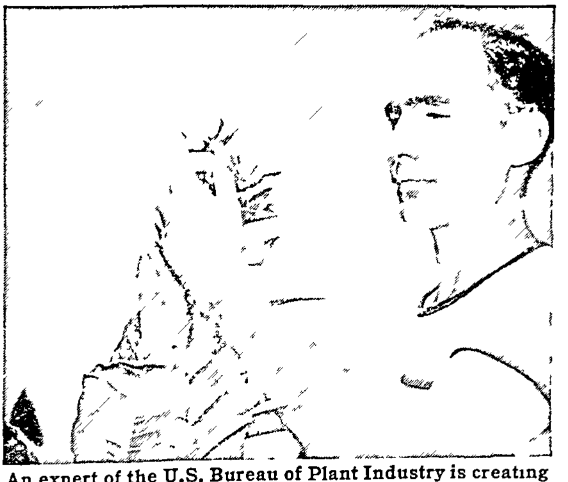
Certain strains of plants have a natural immunity to disease. An observant farmer in Manitoba picked one head of wheat from a rust-free plant in a field of rusty wheat. He saved the seed, increased it by planting, and in a few years had plenty of seed for raising rust-resisting wheat. (*See also* **Plant Diseases** in FACT-INDEX at the end of this volume.)

How Men Improve Plants

"PLANT WIZARDS" they are often called, but plant breeders use no magic—only patience, persistence, and much knowledge of plants. They have two aims—to maintain, and to improve, the quality of economic plants. Their work is based on nature's fundamental law of heredity, stated most simply in Mendel's Laws (*see* Heredity). Left to natural forces, good plants may "run out" in quality. Some plants would die altogether, and those remaining by "natural selection" might be of little benefit to men. A plant breeder replaces "natural selection" with scientific selection of the best, and lets the poorest die. He also "makes plants to order," by breeding to obtain plants with certain desired qualities.

This is done chiefly by cross breeding. The plant breeder begins with a plant that has as many as possible of the desired qualities. Then he chooses a second plant in which one of the qualities lacking in the first plant is very strongly developed. When the flowers of both plants become mature, he takes the pollen (male element) from the second plant and dusts it on the pistil (female element) of the first plant. He hopes that the seed which then develops in the first plant will inherit the new quality he is looking for. If it does so, he may then try to "fix" the new quality permanently by inbreeding plants grown from the new seed for several generations. This means that the blossoms of the new plants are fertilized with their own pollen. From each succeeding generation of plants so produced, he selects as parents of the next generation those that most successfully have kept both the old and the new qualities he desires.

SCIENTIFIC CROSS BREEDING



An expert of the U.S. Bureau of Plant Industry is creating a new variety of tobacco by cross pollination.

When a plant is finally "breeding true" with the good qualities the breeder sought, then he must have its seed tested in various parts of the country where it might grow, in different soils and climates. Other tests may be made on the uses of the plant's products, such as baking tests for grains or cooking tests for fruits. (For the work of a great plant breeder, *see* Burbank, Luther.)

What kinds of improvements are sought in "made-to-order" plants? Most important, perhaps, is the breeding of hardiness—resistance to cold, to drought, to disease.

When a parent growing in a cold region is cross-pollinated with a parent growing in a warm region, the

offspring may become better adapted to endure unexpected winters. A single plant observed to resist rust or smut is bred to one that has a better yield, and some of the resulting plants will have high yield and also resist disease. Practically all the seeds of grains, garden vegetables, and other seed plants sold by seedmen are of some hardy variety.

Plants are also made richer by the breeder's patient skill. Sugar beets had their sugar content more than doubled by breeding. Sweeter fruits, a tobacco stronger in nicotine, and soy beans with more oil are similar achievements. Plants are made to mature earlier or later by selecting parents with those qualities. Thorns have been removed from berry bushes, needles from cacti, and beards from wheat. Fruits and vegetables have been given more desirable colors, flavors, odors, keeping qualities, cooking qualities, and even higher vitamin content. Tomatoes have been given tougher skins for shipping, and more tender skins for canning. Carrots have been given long slim shapes and a richer color. Potatoes have been "streamlined" until their "eyes" are hardly visible and the smooth skin is ideal for peeling. Cucumbers have been made larger for giant pickles, and watermelons smaller to fit in the modern refrigerator.

Flower gardens bear witness to some of the most amazing achievements of plant breeding. New colors, sizes, and shapes of familiar flowers are displayed in every catalog of the seedmen-florists.

In 1930 the United States Congress recognized the breeder of new plants as an "inventor" and passed a law offering him the protection of a United States patent for his product. An everblooming rose, named "New Dawn," was the first patented plant (1931), and for 17 years all nurserymen who sold this rose had to pay a royalty to its originator (*see* Patents). The laws do not permit a grower to patent any variety that nature has already developed or might produce without the aid of man. About two-thirds of the plants now patented are flowers; most of the others are fruits and berries.

The plant breeder works also with cuttings and graftings, especially when he is improving vines and fruit trees; but no permanent changes in the heredity of a useful plant are likely except through the seeds.

Auxins for Growth

Scientists have recently found ways to speed up plant growth astonishingly. They have discovered *auxins*, the substances that make plants grow. Auxins —the word means "helpers," or "promoters"—are members of the hormone family. Animal hormones are secreted in special closed (ductless) glands in various parts of the body (*see* Hormones). They make humans tall or short, fat or lean, strong or weak, quick or slow in motion or in thought—in short, they influence our entire personalities. The animal hormones were discovered about 1900, but plant hormones, or auxins, were not discovered until about 1925.

Auxins are produced at the very tips of growing leaves or buds. They ooze back short distances to growing cells of leaves or stems and stimulate these cells to grow longer. Each large cell finally divides into two smaller ones, which in turn are lengthened by the auxin that soaks into them. All this was proved when botanists stopped the growth of oat seedlings by cutting off the very tips of the plants, and then started it again by rubbing juice from the tips into the cut ends.

Light destroys or weakens auxins; hence if one side of a tip is lighted the other side of the stem below it grows faster, and bends the stem toward the light. Thus for the first time *phototropism* of plants was explained.

Artificial Auxins

In 1934 a Dutch plant physiologist discovered how to prepare a powerful growth-promoting substance from various plant products, such as the malt extract made from sprouting barley. This he called *heteroauxin*—the word meaning "helper of different plants." When heteroauxin is mixed with lanolin (wool fat) to make a salve and is rubbed on any part of a plant, cells grow to great lengths in a few days, forming rootlets. Soon (1935) workers at the noted Boyce-Thompson Institute, Yonkers, N. Y., discovered that certain synthetic chemicals would grow roots in the same fashion. These chemicals, chiefly derivatives of indole (C_8H_7N) such as indole-acetic acid, indolepropionic acid, and indolebutyric acid, were soon on the market —and then "everybody began growing whiskers (roots) on plants with magic ointment". Roots were developed on stems and leaves. One experimenter grew roots on the petals of lilies.

Commercial auxin is manufactured and marketed under various trade names such as Auxilin and Hormodin A. It is expensive but for use it is usually diluted 6,000 times with water. Its practical service is to help gardeners in rooting cuttings that stubbornly refuse to send roots out in ordinary water or damp sand. Camellia shrubs, lemon trees, holly, and other unresponsive cuttings cannot resist the power of auxin. Its astonishing effect on holly is illustrated in the following picture which compares a group of treated and a group of untreated twigs.

An astonishing result followed the application of auxin salve to the pistils of tomato blossoms. *The blossoms produced ripe fruit, even though no pollen had fertilized them.* These "fatherless tomatoes" encouraged similar experiments with other plants.

At the plant laboratories of the California Institute of Technology, Pasadena, plant physiologists experimented with other chemicals to stimulate root growth. They found that a solution of yeast extract, containing vitamin B_1, proved to be a wonder-worker.

Vitamin B_1, Developer of Plants

It is amazing how little of this vitamin (also called thiamin chloride) is required to give a plant a new reason for living. A tiny portion of the white powder no larger than the head of a pin is dissolved in 20 drops of water. Then one drop of this solution is stirred into one gallon of water. Even with this, the warning is given, "Do not use too much!" About one part of this vitamin to 100 million parts of water is the best strength.

Vitamin B_1 produces larger, healthier plants, with flowers of striking size. Five-inch rose buds, snapdragons six feet high, have been reported. A narcissus grew as tall as a boy in one season. Tiny cuttings and seedlings develop at an unusual rate. Plants that will not bloom—often for no apparent reason—change their minds and produce blossoms. Plants that are stunted take on new life; sick plants regain health. This vitamin has saved the lives of large trees that seemed about to die.

If the roots of a transplanted potted plant, shrub, or tree are soaked in the weak solution of vitamin B_1 just before being put into the new soil, root-shock does not occur, and one may say, "The plant does not know it has been moved."

Colchicine, the Wonder Drug

In 1939 Dr. Albert F. Blakeslee of Cold Spring Harbor, N. Y., announced the amazing results on plants of colchicine (*kŏl'chĭ-sēn*) sprayed upon their leaves. Colchicine is extracted from the seeds of the wild meadow saffron, which botanists call *Colchicum autumnale*. Although named after Colchis, an ancient province of Asia east of the Black Sea, this plant was also known to the Aztecs of Central America, who used it as a poison. Early settlers in the United States used weak preparations of it as a remedy for rheumatism and gout. Colchicine is one of the plant poisons called alkaloids and has the chemical formula $C_{22}H_{25}NO_6$.

Dr. Blakeslee's first experiments with colchicine were on jimson weeds, but later he and others sprayed the leaves of tobacco, lettuce, and many berries, fruits, and flowers. He found that this alkaloid, when absorbed by the leaves of rapidly growing plants, caused a doubling of the chromosomes—those carriers of heredity in all dividing plant cells (*see* Cell). This property gives the plant breeders many advantages. Twice as many good qualities can be bred into a plant treated with colchicine—though of course twice as many bad qualities may also result. Crosses or hybrids of plants not closely related have been made strong and fertile, whereas without colchicine such crosses are usually weak and incapable of producing offspring. These hybrids are entirely new plants never grown before!

A brilliant orange marigold, much larger than its ancestors, was the first "colchicine flower" produced. It was named "Tetra" because it has four genes in groups of four instead of the usual two. The picture at the left shows how the big Tetra blossom compares with a blossom of the Guinea Gold variety. The Tetra "breeds true"—that is, its seeds produce blossoms of the new size and color. A hybrid cotton has been produced that combines the long fibers of late-maturing cotton with the early maturity of a short-fibered variety.

Other improvements are crosses of the loganberry and blackberry, and crosses of a far northern blackberry with a far southern type to obtain the best variety for a moderate climate.

Dr. Blakeslee also found ways to halve the number of chromosomes instead of doubling them. He and others have become jugglers of heredity in plants, doing things that nature could not bring about.

Other Ways of Influencing Plant Growth

Experimenters have tried out an amazing number of other methods to change the behavior of plants. X-ray bombardment of seeds has produced astonishing changes because of the effect upon the chromosomes. Short-wave radio waves stunted the growth of corn seedlings or killed them. Neutron bombardment produced one-sided leaves or affected the germination of plants. It has been found that the gradual lengthening of lighted hours in a greenhouse will cause spring-flowering plants to bloom at any season, while the gradual shortening of the lighted hours day after day will bring forth blossoms on fall-flowering plants. Warming the soil by electric cables seems to have helped certain plants to an earlier start in the spring.

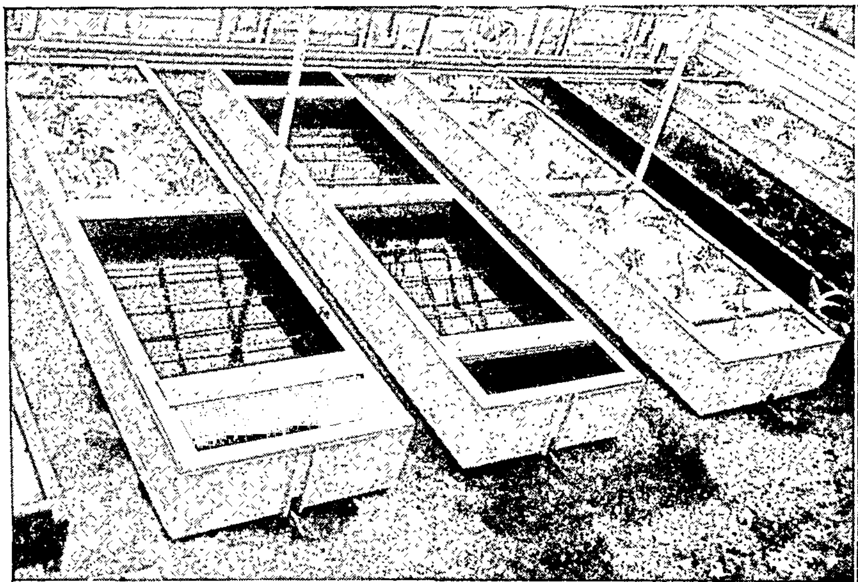
Successful gardeners are often said to have a "green thumb," because the plants they set out always seem to grow well. It is more likely that these gardeners are merely more observant, more patient, more scientific than are the others who have poor luck. These better gardeners are the ones the scientists—botanists, plant physiologists, plant breeders, chemists, and others—can help the most. (*See also* **Plant Improvement** in FACT-INDEX at the end of this volume.)

Hydroponics—Growing Plants Without Soil

FAR OUT IN THE Pacific Ocean lies Wake Island. This island is in actual fact "a thousand miles from nowhere," because its next neighbor is 1,028 miles away (*see* map with article Pacific Ocean). For centuries only the sea birds and turtles made prints in its sands. Then huge wings

of the Pacific *Clippers*—flying boats between California and China—began to drop in a sheltered bay. Before war struck this outpost, men of peace were living there the year round. Passengers from the flying boats stopped overnight. And the food included a rich variety of fresh vegetables.

HYDROPONICS—HOW TO GROW PLANTS WITHOUT SOIL



The picture at the upper left shows three tanks used in chemical gardening. One of them contains only the solution; another is partly covered with excelsior in which tomato plants are growing. In the third tank the planting is completed. In the next picture at the right Dr. W. F. Gericke, pioneer of hydroponics, holds a small wooden tank which anyone can build for home or classroom use. The lower picture shows how the plant roots grow down through the screen to reach the chemical solution.

But how may fresh vegetables be obtained upon a shell-strewn island "a thousand miles from nowhere"?

Not many months before the *Clippers* began to fly the Pacific, Dr. W. F. Gericke of the University of California began to reap huge crops of fresh vegetables grown on small areas entirely without soil. The roots of his plants dipped into wooden and metal tanks containing solutions of the chemicals that are their food. Today, on about half an acre of tanks upon Wake Island, flourishing gardens yield tomatoes, potatoes, melons, carrots, beets, lettuce, cabbage, and other vegetables and fruits.

What is this plan by which one may have a garden anywhere that air and sunshine may be found? Although thousands of people are trying the plan for pleasure or profit, no name for it has been agreed upon. Dr. Gericke prefers the name *hydroponics*—from Greek words that mean "water gardening." Since only chemicals are used, the term *chemiculture* ("growing with chemicals") has been suggested, to contrast with agriculture ("growing in fields"). *Soilless gardening* and *dirtless farming* and *tank farming* and *tray agriculture* have been the titles of many magazine articles about the plan, while those with a sense of humor speak of *bathtub gardens*.

The chief concern of any gardener is to feed his hungry plants. Rich soil contains the right foods, and for centuries it was thought that the soil was their only source. Since black soil seemed richer than light soil, the humus or organic matter from decayed plants was also thought to be a food for living plants. (*See also* Soil.)

These ideas were proved to be largely wrong when a noted German plant physiologist, Julius von Sachs, about 1870 began growing plants in water, to which he added a few minerals. He found that plant roots needed other chemicals for food than the three chief ones—nitrogen, phosphorus, potassium. To these he added calcium, magnesium, iron. Later workers have increased the list to about 20. Of some—like copper and boron—only the smallest traces are required. The chief value of black soil, we now know, is that it holds moisture better than do the light soils, and permits less leaching (washing away) of minerals.

Various Water-Culture Methods

Although water cultures have been common in plant laboratories for decades, it was the work of Dr. Ger-

icke that attracted the attention of the gardening world. In his method, a shallow layer of loose excelsior lies upon coarse-meshed screen wire (such as chicken fence). In this the small plants are anchored. Their roots extend down into shallow trays of wood or metal, filled with hydrant water to which the proper chemical foods have been added. Since roots need air, the water is aerated by a simple air pump.

Under these conditions of ceaseless feasting, plants grow at a rate that is amazing to the dirt-gardener. Dr. Gericke raised 1,226 pounds of tomatoes on a hundredth of an acre. From similar areas came 250 pounds of potatoes, and 100 stalks of celery. From 25 square feet of water came 100 cantaloupes, where the same soil area would have grown but five. The vegetables he grew contained double the amount of minerals valuable in human foods. The juice from his tomatoes was redder than usual.

Sand culture has been recommended particularly by Dr. John W. Shive of the New Jersey Experiment Station. Builders' sand is placed in shallow trays or pots, and the chemical solution drips continuously from tubes upon the sand or rises through wicks. The sand distributes the plant food evenly. Dr. Shive has brought slow-growing plants into more rapid bloom and fruit, and his methods are employed in many florists' greenhouses.

Subirrigation was devised by Dr. Alex Laurie of Ohio State University, Columbus. Shallow watertight tanks are filled with coarse gravel or cinders, and in these the plants are set. Twice a day the solution of minerals flows in from below, filling the tank; after a few minutes it is drained away. Raising and lowering a tub or bucket carries out this irrigation for a small tank. Pumps are used for large tanks. The same solution is used over and over again.

WHEN MAN TAKES A HAND

The cultivated rose (inset) with its many petals was developed by careful selection from the single-petaled wild rose.

Chemicals for Chemiculture

For each of these three schemes of chemical plant feeding the same chemicals are used. There are many different mixtures, or formulas, for experience has shown wide differences in plant requirements. In general, however, these are the minerals and their quantities used for small-scale hydroponics:

For chief elements: In one gallon of hydrant water dissolve (a) ½ teaspoon (tsp.) primary potassium phosphate, KH_2PO_4, to supply potassium and phosphorous; (b) 1½ tsp. epsom salts, $MgSO_4$, to supply magnesium and sulfur; (c) 2 tsp. calcium nitrate, $Ca(NO_3)_2$, to supply calcium and nitrogen.

For trace elements: In one quart of water dissolve (a) ⅓ tsp. (1.5 gm.) boric acid, H_3BO_3; (b) $^1/_5$ tsp. (1 gm.) manganese sulfate, $MnSO_4$; (c) $^1/_{10}$ tsp. (0.5 gm.) copper sulfate, $CuSO_4$; (d) $^1/_{10}$ tsp. (0.5 gm.) zinc sulfate, $ZnSO_4$. In a separate quart of water dissolve 1 tsp. (5 gm.) ammonium iron citrate, which keeps well only by itself. When a gallon of the chief elements is ready for use, add three teaspoonfuls of the solution of trace elements and one of the iron.

This mixture provides 11 chemical elements that plants must have to grow. About ten other elements are needed in such small quantities that hydrant water may be depended upon to supply them.

Advantages of Soilless Culture

All crops that require much space in fields may be grown economically in this way. Tomatoes have given the most surprising yields, but nearly all juicy vegetables thrive well. Crops that are naturally crowded, such as grains and grasses, probably give as high a yield in well-fertilized soil as with tank culture.

Out-of-season crops are now grown by hydroponic methods. Tomatoes have been raised in winter on Cape Cod and sold at high prices in nearby Boston. Flowers that should bloom by Easter or Christmas have their growth retarded or forced by changing the amount of their food and adjusting the hours of light they receive.

Hydroponics offers an unusually interesting hobby for homes or schools. It keeps plants free from soil-borne diseases. They must, of course, be protected from insects and from gas fumes. A very small quantity of the ethylene (C_2H_4) present in household gas will make plants wither and die. A number of firms supply the dry chemicals already mixed, and even the trays may be purchased ready-made. The trays may be homemade.

Research in Photosynthesis and Chlorophyll

In green plants, sunlight shining on chlorophyll provides the energy required to tear apart the molecules of carbon dioxide and water. Their atoms are recombined to form the molecules of sugar and starch. At the same time the oxygen in the water is set free into the air. Thus the green plant creates food without which man and other animals would starve and frees oxygen without which they could not breathe. The process is called photosynthesis. Moreover the green plants of past ages, locked up in the earth, are the fuels of today—coal, gas, and oil.

An understanding of the basic mechanism of photosynthesis would permit scientists to increase food production per unit of light and to use solar energy in many other ways. It might be possible to break water down directly to hydrogen gas with sunlight. Such a process would solve the world's fuel problems by releasing man from his dependence on diminishing supplies of coal, gas, and oil.

Chief among the research workers in photosynthesis are Dr. Otto Warburg, German Nobel prize winner, and Dr. Dean Burk of the National Cancer Institute. In 1951 they announced discoveries which bring scientists closer to a final understanding of this most complicated of chemical processes. To make photosynthesis take place outside the living cell is also one of the projects of the atomic energy program.

The structure of the chlorophyll molecule was first analyzed by Dr. Richard Willstatter in 1913. It is almost identical to the molecule of hematin, one of the compounds in human blood. The center atom of hematin is iron; the center atom of chlorophyll is magnesium. Although chlorophyll contains no iron, the plant cannot make chlorophyll without iron, which it obtains in solution from the soil.

The similarity between blood and chlorophyll led to experiments with the green substance as a healing agent. In the test tube chlorophyll has no power of its own to kill bacteria. In living tissues, however, it inhibits the growth of bacteria. It has been used with success to heal infections, particularly those in deep wounds that are sealed from air.

Because it apparently deodorizes, chlorophyll is being used in toothpastes, mouth rinses, dog foods, cigarettes, shoe insoles, and other products. The manufacturers of these products claim it will prevent unpleasant odors. It is produced chiefly from alfalfa.

MAN-MADE PLASTICS *and Their* COUNTLESS USES

PLASTICS. Imagine how articles made of plastics would puzzle an early American pioneer if he could return to earth. He would think he was seeing new kinds of wood, glass, china, stone, cloth, rubber, jewels, glue, cardboard, varnish, and leather. Today there are plastics which resemble each of these older materials. Some plastics would be like nothing he had ever seen before. He would be amazed to learn that all these materials belong in one family.

Members of the plastics family differ so much in use and appearance that there seems to be little resemblance between them. A boy or a girl who makes a hobby of plastics craft work soon discovers this. Solid plastic materials of many colors can be sawed, carved, and engraved. Certain materials can be melted and cast. Others in the form of fibers can be woven as if they were silk or wool. Still others are leatherlike and can be used for upholstering chairs or for other purposes.

Plastic craftwork offers many fine hobbies. Here the boy is molding figures from hot plastic. The toy machine is a miniature of the big injection presses used to make such articles as combs and brushes.

Many Plastics with Many Uses

In industry these same materials are used in similar ways. Television cabinets, for example, may be molded wholly of plastics. So also may telephones, bases for toasters, automobile steering wheels, and clock cases.

From the rubberlike plastics come films for shower curtains, raincoats, beach balls, laundry bags, baby pants, and aprons. Heavier leatherlike films are used to upholster restaurant furniture, the seats of busses and automobiles, and dining-room chairs.

Fabrics are made from several of the plastics. Everyone is acquainted with the use of nylon in hosiery, in clothing, and even as a fabric for parachutes. Rayon is another familiar plastic.

The bristles in toothbrushes, paintbrushes, and brooms are often plastic. Tennis-racket strings and fishing leaders may also be of plastic.

Many useful things are made of the glasslike Plexiglas and Lucite. Examples are lenses, reflectors, airplane "blisters," costume jewelry, dentures, artificial eyes, signs and decorative murals.

Plastics resins make possible wetproof paper bags, wool that will not shrink, and collars that stay starched. They also furnish strong adhesives, waterproof plywood for boat hulls, and shatterproof glass. Layers of paper or cloth impregnated with a plastic resin are pressed into quiet and long-wearing timing gears for automobiles and into bearings used even for the enormous propeller shafts of giant ocean vessels.

In commerce, as well as in hobby work, crystal-clear Plexiglas and Lucite sheets are fabricated into beautiful objects such as trays, jewelry boxes, salt-and-pepper sets, and lockets. With a fine drill, a craftsman may reach into a transparent acrylic block and carve, say, a flower. Properly dyed, this internal carving gives the appearance of a flower embedded in a

plastic block. By the use of other techniques specimens may actually be imbedded in clear castings.

Snowlike foamed styrene is produced in board form for industrial uses. It is easily worked to make models and many novel decorative items. Vinyl film can be sewed or heat-sealed to make aprons, curtains, baby bibs, and many other items.

The Plastics Have Varying Characteristics

What are these plastics? How is it possible for them to appear in so many forms? How are they suited to so many uses? Three important facts account for the widely different characteristics of the plastics:

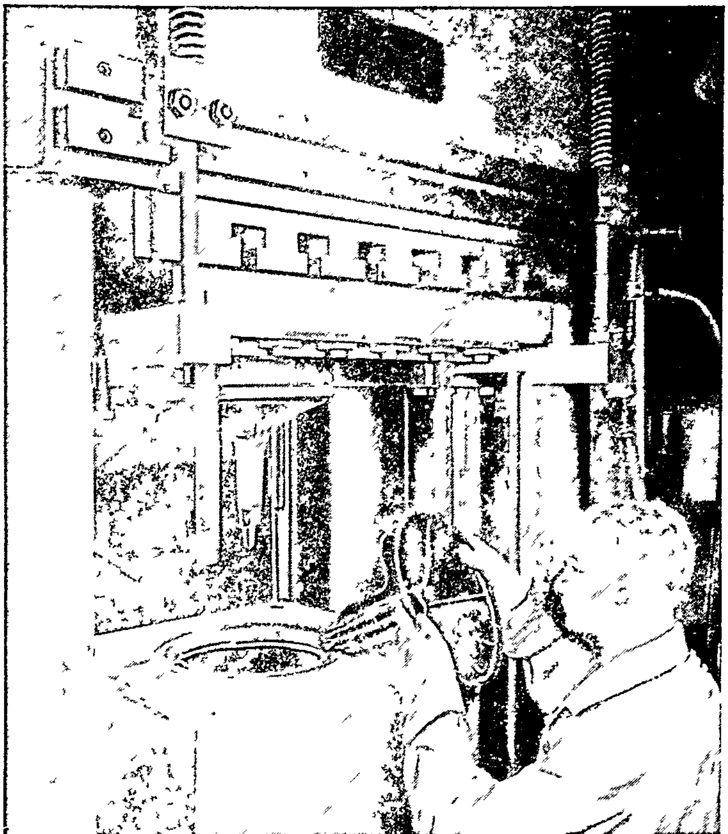
1. There are more than thirty different types in the plastics family, each suited to particular uses.

2. The plastics can be combined with other materials. This permits them to appear in several forms suited to a wide range of uses.

3. There are many methods by which the plastics can be formed into finished products.

In these same three ways, we might explain the many uses of flour. Just as there is white flour, whole-wheat flour, or rye flour, so there are a number of different plastics types. Just as a cook may add shortening to the flour for piecrust, or sugar for cake, so a manufacturer may add various materials to the plastic to alter its uses. Just as the cook forms waffles in a waffle iron or muffins in a muffin pan, so plastics can be formed in different ways. Further discussion of these three points will give some understanding of why the plastics are so versatile.

FORMING PIECES BY COMPRESSION MOLDING



Compression molding is much used for forming durable articles from thermosetting plastic, as explained in the article. Here a factory worker is removing a washing-machine agitator from a compression-molding press.

Types of Plastics

The 30-odd plastics types are *organic* compounds. This means that in each case carbon is one of the elements of which they are composed. Hydrogen, oxygen chlorine, and sulphur are some of the common elements which unite with carbon to form various compounds suited to use in plastics. The plastics chemist has learned to get the elements and compounds he needs from such common sources as coal, petroleum, and cellulose from cotton fiber. Salt, air, water, lime, and sulphur also supply ingredients. The chemist puts these elements and compounds together again in just the right combinations to make the various plastics. This is why most of the plastics are called *synthetic*, or man-made.

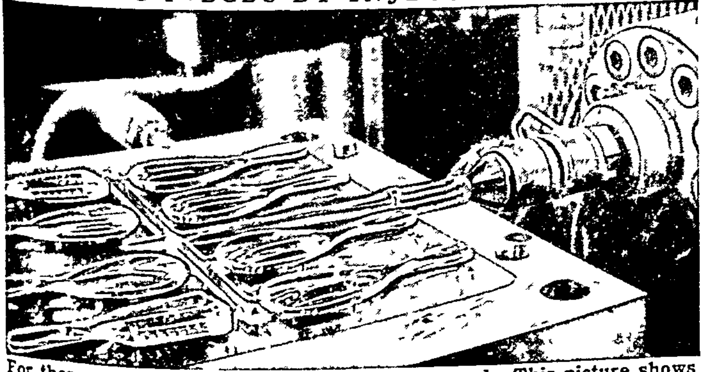
Before the plastics are transformed into finished products, they are often called *resins*. The resins may be in syrupy form, in powder form, in flakes, or in pellets. Most resins can be produced by a materials manufacturer in the best form for a particular use.

Resins Are Combined with Other Materials

The resin *is* the plastic. However, other materials are usually added to the resin before it is transformed into objects such as radio cabinets, washing-machine agitators, or shower curtains. *Fillers* are often added to resins being prepared as molding compounds. Wood flour, cotton, asbestos, mica, and cord are some of these. Such fillers, when added to the plastics resin, might be compared to the sand and gravel added to the cement in making concrete. Each filler used in plastics-molding compounds affects the characteristics of the molded product. For example, asbestos would be used in a piece which had to withstand high temperatures. For high impact strength, pieces of canvas or lengths of cord might be used.

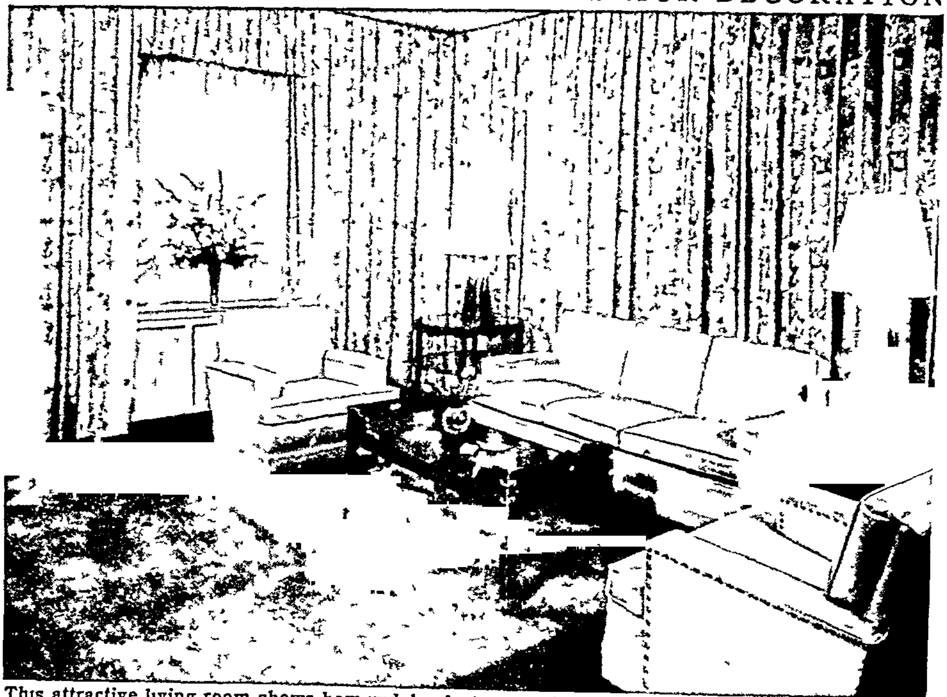
Some plastics resins are dissolved in *solvents* to prepare them for certain uses. For

FORMING PIECES BY INJECTION MOLDING



For thermoplastics, injection molding is often used. This picture shows the lower half of a mold with finished hairbrush backs ready to be removed. Also shown is the nozzle which squirts fluid plastic into the mold.

HOW PLASTICS ARE USED IN INTERIOR DECORATION



This attractive living room shows how widely plastics can be used. Curtains and draperies are of plastic fabric. Lamp shades are a combination of glass fiber and plastic. Chairs and sofa are upholstered in leatherlike plastic, and even the wooden tables are bonded with plastic adhesive.

example, a resin solution might be used to coat a surface. When the solvent had evaporated, the resin would be left as a surface coating.

Plasticizers are sometimes added to make a resin flow better in the forming process. With the addition of a plasticizer, some resins which ordinarily form a rigid product can be made to produce flexible, rubberlike objects. *Coloring agents* are often added to the resin so that the object will be colored throughout. Plastics have this advantage over materials such as wood and metal which can be colored only through the use of paint or other surface coatings.

Plastics Are Formed in Various Ways

The prepared plastics are converted into finished products in a number of different ways. In part the method chosen depends upon the way the particular resin reacts to heat. In one branch of the family are those plastics which soften with heat but stay soft only a short time. Subjected to continued heat, these resins set, or harden. The plastics which react to heat in this way are called *thermosetting*. They might be compared to waffle batter which is converted by heat from a liquid to a solid. No amount of heat can later change the waffle back to its liquid state.

A MURAL IN CLEAR PLASTIC

The design in this decorative panel was engraved on Plexiglas (acrylic plastic). Light from below striking the engraving makes the flowers appear to be lighted from within.

The other members of the plastics family react quite differently to heat. They soften with heat in just the same way; but they will not harden until they are cooled. Such materials are called *thermoplastic*. They can be heated and softened, cooled and hardened, time after time. Thermoplastic resins might be compared to paraffin in the way they react to heat.

Articles made of thermosetting resins may not begin to char until they are subjected to a temperature of nearly 500°F. On the other hand, articles made of most thermoplastic resins will soften and even melt as the temperature approaches 200°F. It is obvious why thermosetting plastics, rather than thermoplastics, are used in forming objects which must withstand heat.

Methods of Forming Plastics

Compression molding uses a molding compound made up of a thermosetting resin and a filler. It is placed in a mold and heated to about 375°F. under immense pressure. The compound becomes semiliquid and pressure forces it into every part of the mold. It soon hardens. The mold can then be opened and the article removed. Telephone handsets, bases for toasters, and handles for pots and pans are examples of compression-molded pieces.

Injection molding is one method used in molding thermoplastics. The molding compound, heated to a semiliquid state, is squirted into the cool mold under great pressure. In a matter of seconds, the molded piece has cooled and hardened so that the mold can be opened and the molded piece removed. Toothbrush handles, combs, and transparent containers are made by injection molding.

Extrusion might be compared to squeezing toothpaste from a tube. A thermoplastic compound is heated and continuously forced through a forming die of the desired shape. A moving belt carries the formed plastic column away as it cools and hardens. Fountain-pen barrels, tennis-racket strings, and moldings

for kitchen counters and for wallboard are extruded in this manner.

Casting uses fluid resins which are poured into open molds. The molded objects are then cured by heating in ovens or by adding a catalyst to speed the cure. Tubes from which craftsmen cut sections to make rings or bracelets were probably formed by the casting method. Resins are available which a craftsman can purchase and use to make his own castings.

Fibers from spinnerets provide the fine threads from which nylon, rayon, and other plastic fabrics are woven. They are made by an extruding process. The liquid resin is squeezed through thousands of extremely small holes in a kind of die called a *spinneret.* The plastic threads are then spun and woven in much the same manner as cotton, linen, wool, and other fibers.

Laminating uses layers of paper, cloth, and wood veneer in various combinations. They are coated with thermosetting resins and bonded together into flat sheets between hot platens of huge presses. Laminates made in this way are practically as strong as steel and may even be machined into gears and bearings. Thin sheets are used for serviceable and decorative table tops and for attractive and durable wall panels. Waterproof plywood for outdoor uses is made by laminating.

MOLDING PLASTIC BY EXTRUSION

Warm plastic is here being formed into a continuous molding by extrusion. A moving belt carries the molding away as it cools and hardens. The worker is checking the size of the plastic ribbon as it emerges from the die of the extruding machine.

Low-pressure molding is used for certain resins which can be formed and cured with little heat and pressure. They permit the molding of irregularly shaped objects which are too large to be formed by steel molds mounted in presses. In this forming method, resin-impregnated materials such as glass fiber, fabrics, paper, and wood veneer are laid on forms of suitable shape. Limited pressure, if needed, may be applied in various ways, and with little or no heat the assembly is cured. Hulls of small boats, fuselage sections for airplanes, and air ducts are formed in this way.

Fabricating uses plastics like wood or metal. Many plastics can be sawed, drilled, threaded, carved, bent, turned, and stamped. Fabricators convert various plastics materials into a wide range of finished products by these and many other machine processes.

Coating is used to give ordinary materials many of the outstanding characteristics of plastics by applying a surface film of plastic. Fabrics such as chintz may have a plastic coating. Or the individual threads may be coated previous to weaving to add strength, color, waterproofing, flameproofing, vermin-proofing, and acid or oil resistance. Wallpaper may be coated so that it can be wiped clean with a damp cloth. Machinery may be protected from rust. Tin cans and tank cars are coated inside to prevent the metal from contaminating food.

The Plastics Industry

The plastics are produced by a young and vigorous industry. Older resins are constantly improved and newer resins having remarkable capabilities are proving their worth and joining the plastics family. Old forming methods are being improved, and new forming methods multiply the uses of plastics.

From chemical companies, the manufacturer of plastic raw materials obtains the ethers, alcohols, esters, acids, aldehydes, amines, phenols, and other raw materials used in making resins. *Plastic material manufacturers* produce the molding compounds, laminating varnishes, casting resins, adhesives, coatings, and sheets, rods, and tubes used by the plastics industry.

The manufacturers of plastics products are the heart of the plastics industry. Included in this group are *molders, laminators,* and *fabricators.* Molding plants include compression and injection presses and extruding machines. From these come most of the plastic articles and plastic parts used in manufactured products. Laminating plants, using huge presses, combine plastic resins with paper, fabric, wood, or fiber to make sheets, rods, and tubes. Fabricators convert sheets, rods, and tubes into many products.

Plastics Names

Familiar as plastics are today, most people do not know them by their real names. In most cases these are derived from the basic chemical compounds of which they are made. Most plastic types are produced by several materials manufacturers, and each gives its own trade name to every plastic it makes. Lucite and Plexiglas, for example, are both methyl methacrylate. In the following list, only the more important types are included. Where a simpler chemical name is commonly used, it is given in parentheses. Their more common uses are also indicated.

Phenol-formaldehyde (phenolics)—molding compounds; laminates; adhesives; cast sheets, rods, tubes
Urea-formaldehyde (ureas)—cast transparent sheets; molding compounds
Melamine-formaldehyde (melamines)—molding compounds
Phenol-furfural (furfurals)—laminating compounds

Alkyds—protective coatings
Casein—buttons, costume jewelry
Cellulose nitrate (nitrates)—sheets, rods, tubes
Cellulose acetate (acetates)—sheets, rods, tubes; molding compounds
Cellulose acetate butyrate (butyrates)—protective coatings; molding compounds
Ethyl cellulose (ethylcell)—protective coatings
Fluorocarbons—gaskets; coatings; tubing; films
Methyl methacrylate (acrylics)—cast sheets, rods, tubes; molding compounds
Nylon—filaments and bristles; molding compounds
Polystyrene (styrene)—molding compounds, foamed resins
Vinyls (several types)—coatings; extruded tubing; films, molding compounds
Polyethylene—coatings; film; extruded tubing
Unsaturated polyesters—laminating and molding compounds

The First Plastics

It was not until about 1868 that the first plastic, cellulose nitrate (called celluloid), was developed. This was the only plastic of commercial importance until casein plastics were produced about 1900 in France and Germany. German scientists developed the phenolic plastic Bakelite in 1909 (*see* Carbolic Acid).

That discovery marked the real beginning of the plastics industry. During and after the second World War the growth of the plastics industry was remarkable. Today there is hardly a common household article which does not use plastics in some form.

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PLATA RIVER. The great estuary called the Plata River, or Rio de la Plata, formed by the junction of the Paraná and the Uruguay rivers, is the outlet for South America's chief commercial region. More than one million square miles, including Paraguay, most of Uruguay and Argentina, and parts of Bolivia and Brazil, are drained by the Plata River system. The Uruguay is about 1,000 miles long, and the Paraná is more than 2,000 miles long.

Though only 225 miles long, the Plata is 25 miles wide at its head and 138 miles wide at its mouth. In flood time it discharges a volume of 2,000,000 feet a second, even more than the maximum of the Mississippi. The muddy current can be observed 100 miles out into the Atlantic.

The Plata brings the commerce of the world to the two great ports on its banks—Buenos Aires, capital of Argentina, and Montevideo, capital of Uruguay. Constant dredging is necessary to keep it navigable, because of the silt deposited by its muddy water. The early belief that silver abounded in this region is shown by the names "Plata" (Spanish for silver) and "Argentina" (from *argentum*, Latin for silver).

PLATINUM. Imagine a cube of silvery grayish-white platinum a foot each way. Not a great mass of metal, you might think. But try to pick it up, and you would quickly find your mistake, for platinum is nearly twice as heavy as lead. This cube would weigh more than half a ton, while a similar cube of coal would weigh only about 80 pounds.

In 1916 this cube would have been worth more than $2,500,000 (at $183 a troy ounce). Since then the price has been unstable, sometimes falling slightly below that of gold. Long considered to be useless, platinum was cheap for many years after it was named in the 18th century. Its name, a diminutive of the Spanish "plata" (silver), means "little silver."

Since platinum resists oxidation, acids, and heat, it has taken its place among the most useful of metals. It resists any one of the common acids, but it can be dissolved in a mixture of nitric and hydrochloric acids. It withstands terrific heat; its melting point is about 3,190°F. For most purposes, it is alloyed with one of the other metals of the platinum group or with silver, gold, copper, nickel, or tin.

The chief use of platinum is in making jewelry. Because it is easily worked, the metal is used pure for fine chains and settings for diamonds. For hard jewelry it is alloyed with iridium. This durable alloy is used also to make national standards of weight and measure and for the writing tips of fountain pens.

Platinum serves many purposes. It is used for crucibles, screens, and other equipment indispensable to the chemist. Platinum-gold alloys are used in spinnerets to resist caustics in the manufacture of rayon.

In its finely divided forms—platinum sponge, platinum black, and platinized asbestos—it has been one of the most useful of catalysts. These bring about chemical reactions without being themselves affected by any permanent change. For instance, hydrogen and oxygen are ordinarily indifferent to each other. But hold a bit of spongy platinum in a stream of escaping hydrogen, and the hydrogen will unite with the oxygen of the air, taking fire. Platinum is used as a catalyst in hydrogenating animal, vegetable, and mineral oils (*see* Hydrogen). It is so used in making butter and lard substitutes and in hydrogenating gasoline to increase its octane rating.

Because platinum expands very little when heated, it is much used in devices for measuring temperatures too hot for ordinary thermometers (*see* Pyrometer). It expands at about the same rate as glass, and so it was formerly used for the lead-in wires of electric light bulbs. These wires are now made of cheaper metals, notably *platinite*, an alloy of iron and nickel. Another useful property of platinum is its extreme

ductility. A single ounce could be drawn out into a wire, finer than a spider's thread, that would reach from New York to New Orleans. Platinum wire 30 times finer than human hair is used for fuses in delicate electrical instruments.

Platinum occurs in small grains, flat scales, or nuggets, associated with gold, copper, or nickel, or with one or more of the five other platinum metals—iridium, osmium, palladium, rhodium, and ruthenium. In some years, Canada produces half or more of the world's platinum. Russia ranks next, followed by Colombia and the Union of South Africa. The output of the United States is small. The chief producers are California, Oregon, and Alaska.

The specific gravity of platinum is 21.45. It is one of the heaviest of metals, only a little lighter than osmium and iridium. On Mohs's scale, platinum has a hardness of 4.3, about the same as that of iron. Symbol, Pt.; atomic number, 78; atomic weight, 195.23; valence, 2 and 4.

PLATO (*plā'tō*) (427-347 B.C.). Of all the sages and philosophers of ancient times, Plato is the best known and the most widely quoted. His many writings have been made the basis for an endless number of moral, religious, and political doctrines.

Born of aristocratic parents, Plato received the customary Athenian education in poetry, music, oratory, and gymnastics. At about the age of 19 he became a pupil and friend of a brilliant teacher, the great Socrates. Plato remained with him until the latter was put to death by the Athenians in 399 B.C. Plato assisted and defended the master at his trial (*see* Socrates). This association had the profoundest influence on the young man and shaped all his later thoughts and his writings.

The next ten years Plato spent in travel, visiting Egypt and other Mediterranean countries. In Sicily he incurred the enmity of Dionysius, tyrant of Syracuse, who had him sold as a slave. He was ransomed by a friend and returned to Athens. There he set up a school in the famous Academy, a pleasure ground about a mile outside the city. Beneath the lofty trees, Plato taught philosophy to the youth of Greece until his death at 80. Plato's fame spread over all the civilized world and brought him many pupils who later became famous. Chief among these was Aristotle, who was destined to surpass his master in certain departments of philosophy (*see* Aristotle).

Plato left behind him a great number of works, mostly in the form of dialogues, in which Socrates appears as the leading character. It is chiefly through the mouth of his old teacher that Plato sets forth his doctrines. These are presented in the Socratic method of reasoning by question and answer. Written often in a high, almost poetic vein, they are nevertheless examples of severe and subtle thinking. Benjamin Jowett (1817-1893), the English scholar noted for his excellent translations of Plato, said that "the germs of all ideas, even of most Christian ones, are to be found in Plato." The best known of Plato's works are the 'Republic', in which he outlines the ideal government; the 'Symposium', in which a group of banquet guests discuss ideal love and beauty; the 'Timaeus', which deals with the nature of the physical universe; and the 'Apology', presenting a vivid portrayal and defense of Socrates.

GROWING *and* LEARNING *Through* PLAY

This little girl is using her sand toys to explore the seashore. Her eager curiosity extends to the limits of her known world.

PLAY. Any activity engaged in solely for the enjoyment it gives is play. It differs from work, which may or may not be pleasurable, but which has value as its end result. This end result, whether praise, money, promotion, or some other value, is the important element in work. Play also differs from drudgery, which is never pleasurable and whose end result means little or nothing to the person forced to engage in it.

What is play to one person may be work or even drudgery to another. For example, a child with musical talent may prefer playing the piano to playing with toys or with other children. To another child, playing the piano may be work in that he wants the prestige of performing in school concerts or praise from family friends for his performance. To still another child, playing the piano may be drudgery. He does not enjoy it, nor does he see any benefit from the hours of practice forced on him by his parents.

Thus whether it is play or something else depends upon the individual's attitude toward it. What are commonly called play activities are simply those that the majority of people regard as play.

Types of Play

Because play is *any* enjoyable activity, there are many different types of play. Almost all children en-

gage in some activities, and regard them as play, which adults might regard as work or even drudgery. For example, adults might class knitting, baking cookies, or making things out of wood as work or drudgery. Because the child does these activities voluntarily and continues only as long as they are fun, they are forms of play. American children engage in the following types of play:

Exploratory play satisfies the child's curiosity. Babies like to pull their hair and poke their fingers into their noses, eyes, and navels. They get fun from watching their fingers move, sucking their fingers and toes, and looking at themselves in the mirror. Later they like to explore everything within reach, such as toys or any object in the home. Exploratory play does not die out with babyhood. Children love to explore empty houses, attics, basements, and everything in the homes and stores they visit. They like to go on hikes and picnics to explore new terrain and on motor trips to new areas of the country.

Make-believe play is popular between the ages of three and six. During these years the child's imagination develops faster than his reasoning ability. He can imagine himself a policeman, a sailor, a flier, or any other person he wishes. He imagines his stuffed animals, dolls, or tin soldiers have life qualities, and he plays with them as if they were living creatures. A few stage props and a bit of costuming are all he needs to help dramatize events of interest to him.

By the time the child reaches school age, his reasoning ability has developed to where it acts as a check on his unbridled imagination. As a result, make-believe play loses some of its appeal. He gradually abandons it for other forms of play more in keeping with his increasingly mature level of development.

Constructive play consists of making things just for the fun of doing so. It may be building houses in sand, painting, crayoning, modeling in clay, weaving, knitting, cutting and pasting, or making collections. While he often uses what he makes, this is not the primary reason for the construction. The fun of making it is what appeals to him.

Games are play in which the child usually competes with others in activities controlled by some rules. Games may be played indoors—the "mother" games of babyhood, as pat-a-cake or peekaboo, and the card and guessing games of older children. They may be played outdoors, as tag, hide-and-seek, or cops-and-robbers. In early childhood outdoor games are more popular. In late childhood and adolescence indoor games, especially the guessing and card games, predominate. (*See also* Games.)

Sports are similar to games in that they have rules and regulations. They differ in that the rules are stricter, each player usually has a specific role to play, and all sports require strenuous physical exertion. Favorite American sports are baseball, football, basketball, tennis, bowling, hockey, and swimming races. Boys are usually fonder of sports than are girls, although both indulge in sports appropriate to their own sexes.

WORK OR PLAY?

For these children, rolling this log is sheer play. To an adult, a similar task might be work or even drudgery.

Amusements are forms of play in which the child gets pleasure from being a spectator. Among younger children, looking at the comics and at television, being read to, and listening to the radio are favorites. Older children like to read to themselves, watch television, listen to the radio, and go to movies. At every age—childhood, adolescence, adulthood—watching people do things, watching animals, and listening to music are popular amusements.

Values of Play

Play has many values for the child. It is a good way to keep him occupied and out of mischief. Even better, it serves to promote growth and development. Children who have the time and energy to play develop into healthier, more wholesome people than do children whose playtime has been limited by poor health or by the necessity for assuming adult burdens. Further, children who are encouraged to engage in many types of play have a better rounded development than those whose play is limited to a few activities.

Physically, the child benefits from play by strengthening his muscles, by developing co-ordination or skills that will serve as foundations for skills he will use later in life, and by developing a healthy appetite. He uses up excess energy which would otherwise find outlet in nervous mannerisms or interfere with restful sleep. Resistance to disease is also increased by play, especially by strenuous outdoor games and sports.

The psychological values of play are even greater than the physical. Memory and imagination are harnessed and used for many of the child's play activities. He learns to concentrate attention on things that interest him, an ability that will prove useful in school and in later life. Through play with other children, whether with toys, games, or sports, the child learns to co-operate, to be a good loser as well as a good winner, a follower as well as a leader. He develops initiative and ingenuity in planning play activities. These are qualities he can use all his life.

PLAY AT BOTH WATCHING AND DOING

Here at a children's zoo, young people get a chance to observe small animals at close range and even to play with them.

Butt piling and concrete pipe make good play equipment for crawling and climbing youngsters at this park playground.

Playing leapfrog is one of the best and simplest ways to learn the give-and-take of real life that children must one day know.

Personality traits that lead to good social adjustments are developed better in childhood play than in any other way (*see* Personality). The child learns to share, to be unselfish, to co-operate. He learns to be honest, to respect the rights of others, to submerge his personal interests for the sake of the group. He learns to share the limelight with others instead of demanding it for himself and to be cheerful no matter how things turn out. The more of his playtime spent in play with other children, the more likely these personality traits are to develop.

In play the child develops important attitudes toward the problems of life. From play he learns to approach any activity with a "this is fun" attitude instead of looking at it as a task that must be done whether he likes it or not. The more he plays, the more firmly established this attitude will be and the more likely it will carry over into everything he does as he grows older. Finally, from the child's play come interests that frequently develop into lifelong hobbies. These hobbies may prove to be the greatest benefit derived from play.

Essentials to Play

Because play means so much to a child, it is important that he gets maximum benefit as well as maximum pleasure from it. If play is to mean all it should, the following essentials must be fulfilled:

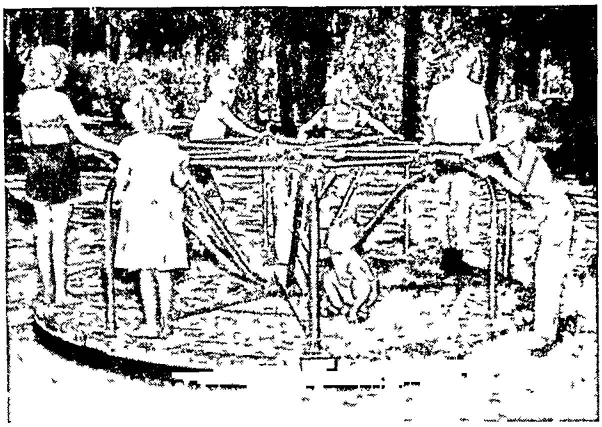
1. *The child must learn how to play.* Play is not an instinct; it is learned. Merely giving the child play equipment and time to play is not enough. He must be shown how to use them in a way that will give him the most enjoyment. True, children will work out ways of using their toys, balls, crayons, and sand for themselves. However, without the help of someone more experienced than they, they are likely to work out play methods that will offer far less enjoyment than they could have if some direction were given.

2. *The child must have play equipment.* This does not mean toys alone but equipment for every type of play—looking at pictures, listening to music, playing games, or making collections. Only when a child has a variety of play equipment and adequate space to keep it will he be able to play in enough different ways to avoid boredom.

3. *The child must have energy for play.* When a child has many responsibilities at school or at home, he will be too tired to enjoy the playtime he has. The child in poor health or suffering from some chronic ailment is likely to limit his play to activities that require a minimum of exertion. Only when a child is in good health and when his energy is not sapped by other exertions can he get the maximum pleasure from play. Only then can he engage in enough different types of play to get the physical and psychological benefits play should give.

4. *The child must have space to play in.* A baby can enjoy his toys and explore his body and his environment in a small place. With each new year the child's play becomes more varied and needs more space. When deprived of space, as in the slum districts of large cities, children are forced to use the crowded

OUTDOOR AND INDOOR PLAY



This merry-go-round is also great fun for climbing and playing tag. It is suitable for children from many different age groups.

Pinning the tail on the donkey is one of the best of party games, and it is enjoyed by younger and older children alike.

streets and sidewalks. Many children in limited space confine their play to types which require a minimum of exertion.

5. *The child must have playmates.* There are certain types of play that can be carried out alone, but they are few and not too much fun. For example, a child can read, look at comics, listen to the radio, watch television, play with some of his toys, or even play some indoor games alone. But most forms of play are more fun if other children participate.

When a child lacks playmates, either because of geographic isolation or because he makes himself unpopular, his scope of play activities is greatly limited. As a result he loses many of the benefits play can give. The child who has many playmates has the opportunity to engage in almost every type of play and is thus seldom bored. The monotony of playing in the same way day after day is relieved, and his play proves more beneficial to him.

Play Changes with Age

As children grow older, marked changes take place in their types of play and in the amount of time devoted to them. These changes result partly from physical and mental development and partly from environment. For example, a child who enjoys playing with toys may be forced by social pressures or by ridicule from his friends to abandon it sooner than he himself would outgrow it. Social pressures determine to a large extent what form of play he will engage in at different ages. For example, if baseball is the popular sport in his neighborhood, he will play it even if he prefers some other sport.

With each passing year, the child has less time to play than he formerly had. School and home duties take more and more of his time. Even though his waking hours gradually increase, he still does not have as much playtime as before. The greatest decrease in playtime comes in adolescence, when the child goes into junior or senior high school, and later as a young adult, when he goes to college or to work. The reduced playtime forces the child to select the type of play which best fits into his daily life and which is popular among his friends.

Specific names have been given to different ages characterized by certain forms of play. Babyhood is known as the "exploratory play age" because most of the baby's play is exploratory. The preschool years are called the "toy age" since most of a young child's play revolves around toys—for dramatization, for construction, or for exploration. Late childhood, from the time of entering school until biological maturing sets in, is referred to as the "play age."

The "play age" is so called because at this time there is a transition from simpler to more complex play. At first the child plays much as he did when he was younger, with toys and with his playmates in simple neighborhood games. Each year as his body grows and his mental development advances, the simple play of his earlier years becomes less and less adequate. Gradually he gives up his toys and games in favor of more mature types of play, sports, movies, reading, and construction.

By the time the child reaches adolescence, he has largely put aside childish play. Now he plays much as a young adult does. He concentrates on sports as an active participant or as a spectator. He enjoys dancing and talking with members of the opposite sex. He reads, especially fiction with adventurous or romantic themes. He likes to listen to music, to go to the movies, to make things, and to watch television. Narrowing down of playtime brings a narrowing down of play interests. The forms of play he carries into his adult years depend partly on how much free time he has for play and partly on what he finds most enjoyable as he progresses through the childhood years. (*See also* Adolescence; Child Development.)

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(*See also* Book list on Games.)

Simple Games from Babyhood to School Days

ALTHOUGH the small baby is too young to play romping or complicated games, there are many simple games to play, which will develop both body and intelligence. The simplest is probably "Peek-a-boo."

"This is the way the ladies ride!"

Peek-a-boo. The mother hides her face, says "Where is mother?" and then peeps out with the call of "Peek-a-boo." "This little pig went to market," played on the toes, is another old favorite.

Most babies like to be danced on the knee or on a prancing foot. An amusing nonsense verse may accompany the trotting, which is good exercise for the baby's body:

This is the way the ladies ride;
Tri, tre, tre, tree,
Tri, tre, tre, tree!
This is the way the ladies ride,
Tri, tre, tre, tre, tri-tre-tre-tree!
(*Move foot with quick jerky up-and-down movement*)
This is the way the gentlemen ride;
Gallop-a-trot, gallop-a-trot!
This is the way the gentlemen ride,
Gallop-a-gallop-a-trot!
(*Move with slow long up-and-down movement*)
This is the way the farmers ride;
Hobbledy-hoy, Hobbledy-hoy!
This is the way the farmers ride;
Hobbledy-hobbledy-hoy!
(*With "hobbledy-hoy" move foot with wide sidewise movement almost throwing child off*)

Here's a Ball. Finger plays, such as "Pat-a-cake," have always been popular. One of the favorites is "Here's a ball for Baby," played as shown below.

Here's a ball for Baby,
Big and soft and round!
Here is Baby's hammer—
O, how he can pound!
Here is Baby's music—
Clapping, clapping so!
Here are Baby's soldiers,
Standing in a row!
Here is Baby's trumpet,
Toot-too-toot! too-too!
Here's the way that Baby
Plays at "Peek-a-boo!"
Here's the big umbrella
Keeps the Baby dry!
Here's the Baby's cradle,
Rock-a-baby-by!

"Dance, Thumbkin, Dance"

Dance, Thumbkin, Dance. Whenever the word "Thumbkin" occurs in this game, the thumbs should be kept in rapid motion. At the word "merrymen," all the fingers are in fluttering movement; and so with "Foreman," the first finger; "Longman," the second finger; "Ringman," the third finger; and "Littleman," the fourth finger.

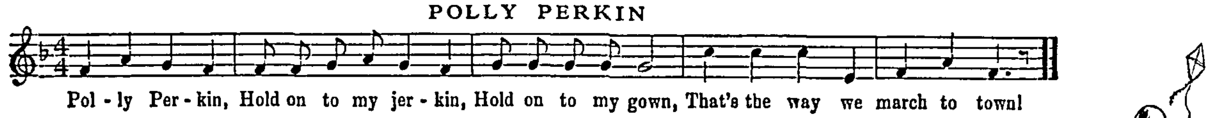
Dance, Thumbkin, dance,
Dance, ye merrymen, everyone.
For Thumbkin, he can dance alone,
Thumbkin, he can dance alone.
Dance, Foreman, dance,
Dance, ye merrymen, everyone.
But Foreman, he can dance alone,
Foreman, he can dance alone.
Dance, Longman, dance,
Dance, ye merrymen, everyone.
For Longman, he can dance alone,
Longman, he can dance alone.
Dance, Ringman, dance,
Dance, ye merrymen, dance.
But Ringman cannot dance alone,
Ringman, he cannot dance alone.
Dance, Littleman, dance,
Dance, ye merrymen, dance.
But Littleman, he can dance alone,
Littleman, he can dance alone.

Simon Says "Thumbs Up." The leader calls out "Simon says 'thumbs up'," "Simon says 'thumbs down'," or "Simon says 'wiggle waggle'." The other players must do what Simon *says*, not what he *does*. The leader tries to confuse them by using the wrong action with his thumbs.

"HERE'S A BALL FOR BABY," A FAVORITE OF THE VERY YOUNG

A small baby, even before he can talk, enjoys hearing his mother recite "Here's a ball for Baby" and watching her make the gestures as shown in these pictures. In the first picture her gesture represents the ball, (2) the hammer, (3) the music, (4) the soldiers, (5) the trumpet, (6) peek-a-boo, (7) the umbrella, (8) the cradle. The verses are given in full in the text above.

POLLY PERKIN



"Polly Perkin, hold on to my jerkin."

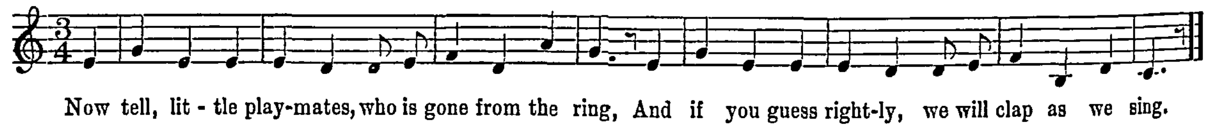
As soon as the baby can walk, he enjoys games which involve marching or running around while singing a lively tune, such as "Polly Perkin." A number of other games and amusements for small children are described in the following suggestions.

Polly Perkin. The children form in line, grasp the dress or coat of the child ahead, and march about, perhaps through several rooms, singing the song above.

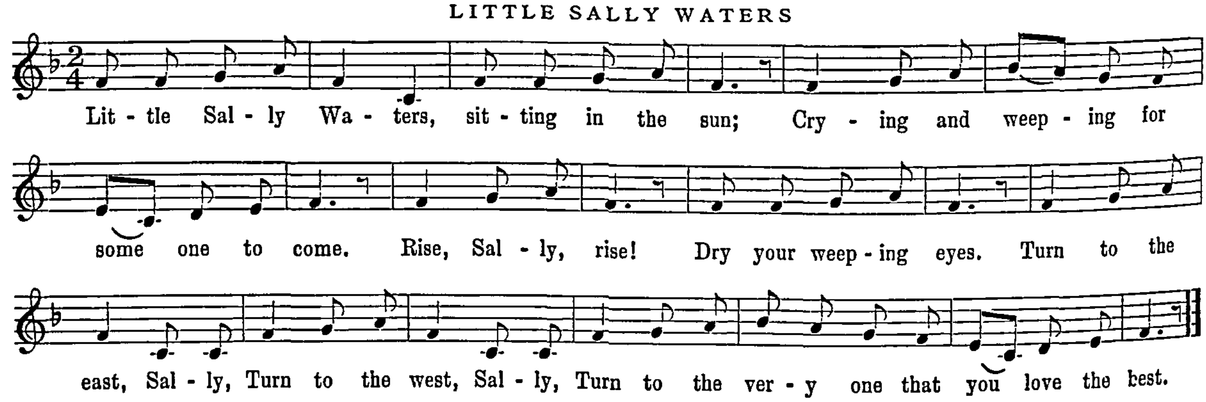
Guessing Game. The players form a circle, with one child, blindfolded, in the center. One child in the ring goes quietly out of sight; then the blindfold is removed from the child in the center. The children sing the song given below, while the center child tries to guess who left the ring. If he fails, he has a second trial while a different player leaves the ring. After that, another player is chosen to be blindfolded.

Little Sally Waters. Another singing game of which a party of little tots never tire is "Little Sally Waters." They catch hands and form in a circle around "Sally"

GUESSING GAME



LITTLE SALLY WATERS



who sits in the center of the circle; as they sing they slowly circle around "Sally." As the last word is sung they all stop. "Sally" rises and makes her selection. The one selected becomes "Sally" and the song and game starts over again.

Human Ten Pins. A group of 8 or 12 children stand in a row like bowling pins. Ten or fifteen feet away a line is drawn on which the "bowler" stands. He rolls a soccer ball towards the human ten pins, and the pin which is struck falls to the ground. If in falling the pin strikes another pin, that one also falls over. The dead pins then leave the group and the bowler has a second turn. The last pin standing takes the place of the bowler in the next game. If more than one pin is left after two throws, the bowler may choose who is to be the next bowler. In scoring, each pin knocked down counts one point.

Quack, Quack. This game requires 9 or 10 children and may be played by many more. The child who is to be "It" is blindfolded and stands in the middle of a ring made by the others. He holds a cane. The children in the ring move quietly around. After a while, the blindfolded child raps on the floor with his cane, and the children stop moving. The blindfolded one then puts his cane on some child in the ring. The child touched by the cane must say "Quack, quack" in a disguised voice. If the blindfolded child guesses whom he has touched, then that child becomes "It."

PLEIADES (*plē'ya-dēz*). The group of fixed stars known as the Pleiades were once, according to Greek mythology, the seven daughters of the Titan Atlas. According to one story, they killed themselves from grief at the fate of Atlas, their father, who was compelled to bear the weight of the heavens on his shoulders. According to another, they were companions of Artemis (Diana) and were rescued from the hunter Orion by the gods and set aloft in the sky. Only six of the stars are easily visible. The seventh, called "the lost Pleiad," was said to hide herself for shame because she had married a mortal. There are scores of fainter stars in the group, which forms part of the constellation Taurus (the Bull).

PLOVER (*plŭv'ẽr* or *plō'vẽr*). Some of our greatest bird travelers belong to the plover family. Most of them cover great distances in the fall and winter migrations, but the golden plovers and the semipalmated plovers are the champions, for they breed in the Arctic and winter in South America from Brazil to Patagonia. (For map showing the routes of the golden plover, *see* Migration of Animals.) The Pacific golden plover migrates between Alaska and the Hawaiian Islands, China, and Australia. Black-bellied plovers breed all around the rim of the Arctic and migrate south to Australia, India, South Africa, and South America. Killdeers winter from New Jersey, Indiana, and California to as far south as Venezuela and Peru. They breed from central Mexico to northern Canada.

These members of the shore-bird group are smaller than most of their relatives, ranging from 7 to 12 inches. Since their short bills are not well adapted to digging in mud or soft sand, they often feed far inland. They usually lay four dark-spotted eggs in nests on the ground. In summer plumage, the black-bellied plover is blackish brown below and black and white above; above the eye its head is white. The golden plover is black underneath with conspicuous yellow spots above. The semipalmated plover has a black ring around its neck, with crown and upper parts dark brownish gray and lower parts white. The killdeer is white underneath and olive brown above, with two black bands on the breast and two on the head. (For pictures in color, *see* Birds; Egg.) The killdeer destroys many insect pests.

Among the Old World plovers are the golden, the gray, and the ringed plovers. An interesting bird is the spur-winged plover, or crocodile bird. It is an African plover which picks parasites from the mouth of the crocodile (*see* Crocodile).

Closely related to plovers are the lapwings, or green plovers, which occasionally stray across the Atlantic Ocean to North America.

Plovers, with snipe, sandpipers, avocets, stilts, and other shore birds, form the superfamily *Charadrioidea*. Plovers belong to the family *Charadriidae*. The scientific name of the black-bellied plover is *Squatarola squatarola*; of the American golden plover, *Pluvialis dominica*; of the semipalmated plover, *Charadrius semipalmatus*; of the killdeer, *Oxyechus vociferus*.

PLOW. The plow is the basic tool of the farm. It is the first implement used in preparing a seedbed for crops. With it the ground is broken and pulverized. Plowing also adds more humus and general fertility to the soil by covering the vegetation and manure. It destroys weeds. It helps the soil retain moisture and circulate air. It destroys insects and helps prevent wind erosion.

The *moldboard* plow is widely used. It is good in many kinds of soil and is especially useful in turning under and covering crop residues from the previous season. The *disk* plow is used for soils that are sticky when wet and hard when dry.

The Moldboard Plow

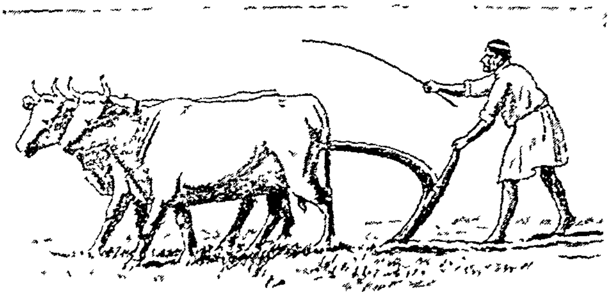
The working part of the moldboard plow is called the *bottom*. Its parts—the *share*, the *landslide*, and the *moldboard*—form a three-sided wedge. It uproots and turns over the *furrow slice*, leaving an open trench, or furrow, ready for seeding.

The simplest type of moldboard plow is the walking plow, shown in the picture below. The sulky plow is horse drawn and has a seat for the operator. The single-bottom plow is balanced on two wheels and is pulled by a tractor. Gang plows are tractor-drawn moldboard plows with two to five bottoms. Some two-bottom and all three- or more bottom plows have a rear furrow wheel in addition to the two side wheels. There are also many special-purpose moldboard plows.

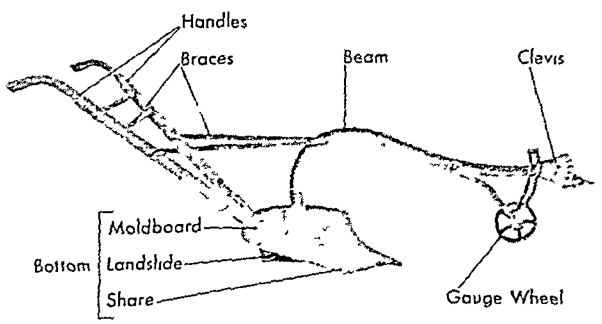
The Disk Plow

The disk plow is a round concave steel disk, sharpened on the edge and varying from 24 to 34 inches in

ANCIENT AND MODERN PLOWS

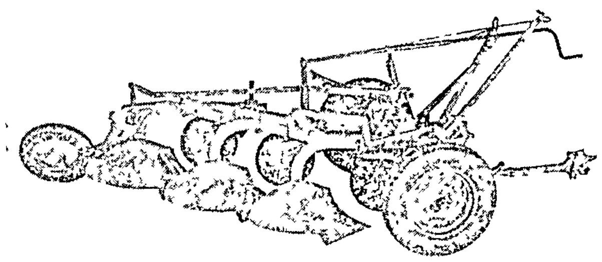


Primitive wooden plows like this could do little more than scratch the surface of the soil. Similar ones are still used in the more remote parts of India and Africa.

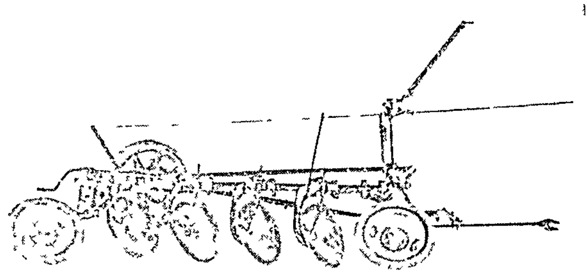


This simple walking plow is used today on small farms. The first successful steel walking plow was invented by John Lane in 1833. Later moldboard plows are adaptations of this one.

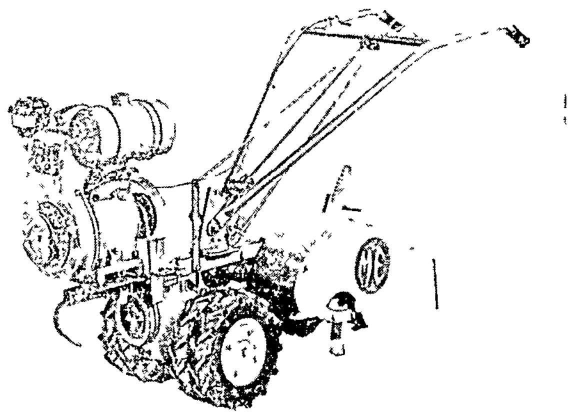
THREE POPULAR PLOWS



This triple-bottom gang plow is of the moldboard type. It has two side wheels and a rear wheel. It is tractor drawn.



This trailing four-bottom disk plow is pulled by a tractor. The two solid wheels are furrow wheels; the third is a land wheel.



Designed for the gardener, this self-propelled rotary plow turns the soil and prepares the seedbed. The operator walks behind.

diameter. It rolls instead of slides along the furrow. The disk plow is used in earth too hard for the moldboard; and it scours, or cleanses itself, in earth that is inclined to stick to the moldboard.

The sulky disk plow is a horse-drawn single-bottom plow with a seat for the operator. The gang disk plow is horse drawn and has two or more bottoms. The trailing disk plow is pulled by a tractor. As its name implies, the direct-connected plow is hitched directly to a tractor. It has a single rear wheel. The integral-mounted disk plow is part of the tractor itself, mounted on the side between the front and rear wheels.

The rotary plow is unlike the moldboard or disk plows. It has a series of cutting knives, or *tines*, mounted on a horizontal power-driven shaft. Some types are tractor drawn; others are self-propelled.

PLUM. Wild and cultivated plums come from America, Asia, and Europe. They range in size from a cherry to an egg and vary in color from purple or dark blue to red, yellow, or green.

The United States is well supplied with hardy varieties adapted to all kinds of soil and practically every section of the country. When this continent was first settled by white men, many varieties of plums were found growing in different regions. These have been improved by cultivation and flourish in the orchards of their native regions. Among them are the comparatively useless beach plum of the Atlantic coast; the Canada, the Chickasaw, and the wild red, each in its section; and the wild goose, also a red plum, popular in the Central States. It is so called because the parent tree grew from a seed taken from the crop of a wild goose.

In addition to the native varieties, cultivated plums from Europe have been introduced and flourish especially in the New England States and on the Pacific coast. Among these are the English damson, a small oval purple plum, and the small high-flavored green gages, as well as a number of egg plums. Many fine varieties of Japanese plums are adapted to growth in the Pacific coast region. This region is the leader in plum growing and the center of the important prune industry of this country. The prune is a plum (all plums belong to the genus *Prunus*) and the most important food variety. (*See also* Prune.)

The Bartlett plum is a "sport" variety which has the flavor of a Bartlett pear. It was developed by Luther Burbank. Plums with small stones and without any stones at all have also been developed under cultivation. Plums are grown from seed only for the sake of new varieties; old varieties are perpetuated by budding and grafting.

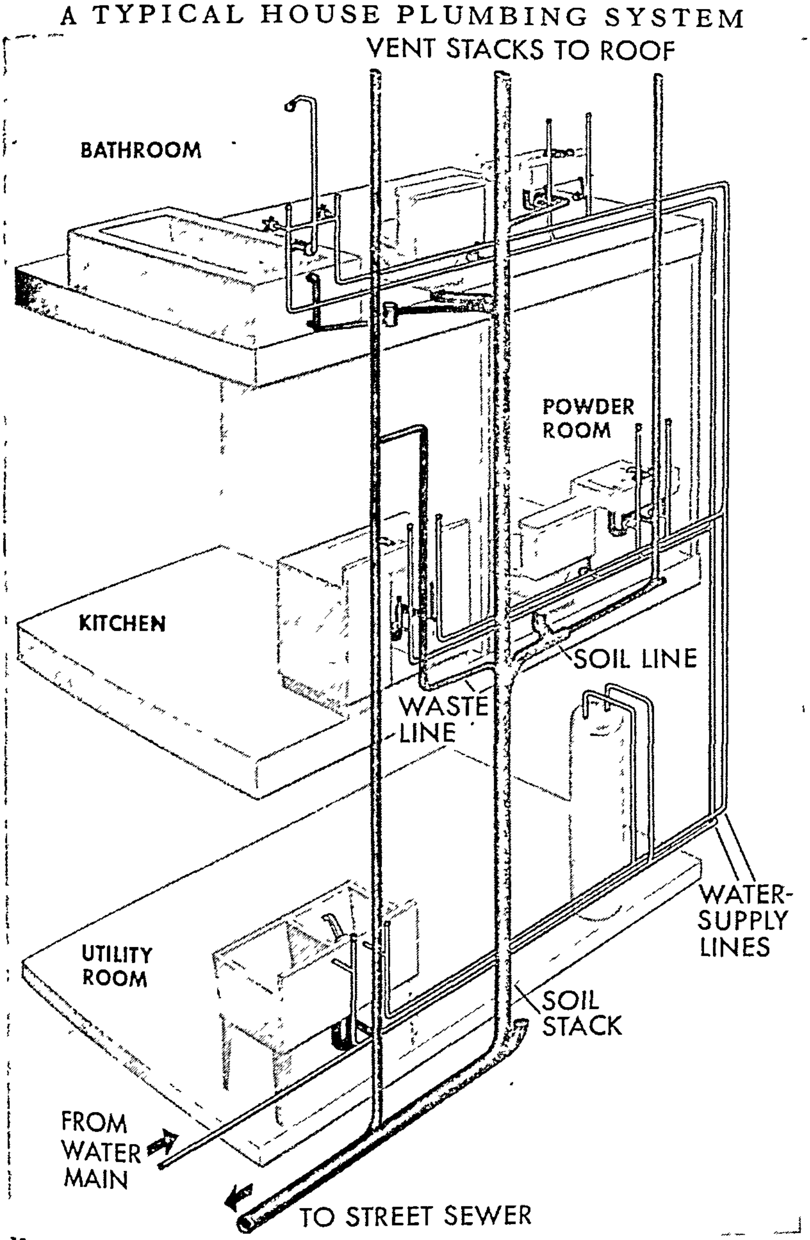
PLUMBING. The supply of water and the disposal of sewage in homes and other structures have become highly developed in the 20th century. Throughout the world the United States is known for its efficient plumbing, both in urban and in rural areas. Clean, attractive bathrooms promote health and prevent disease. Laborsaving kitchens make the housewife's tasks of cleaning and cooking easier and more convenient.

In cities, water mains and sewers under the streets supply water and dispose of sewage from buildings (*see* Water Supply; Sewerage). On farms, wells and septic tank systems must be installed for these purposes (*see* Water; Pump).

The supply of germ-free water and the safe disposal of sewage are important for public health. Therefore states and cities have plumbing codes or regulations. Usually permits are required for installations and the work must be inspected. Some codes permit only licensed plumbers to install plumbing.

Parts of a Plumbing System

Plumbing is the installation and maintenance of pipes and fixtures for carrying and using water, liquids, and gases. Plumbers may install heating plants, gas lines, and refrigeration equipment, but usually specialists do this work.



Much of the plumbing is hidden in walls and floors. The chief parts are *fixtures, water-supply lines* for clean water, and *drainage lines* for used water and venting.

House plumbing consists of three main divisions: fixtures, water-supply system, and drainage system. Plumbing *fixtures* serve many purposes. The bathroom may have a washbowl, bathtub, shower, and water closet. In the kitchen there is a sink, perhaps with a dishwasher or garbage disposer. The basement or utility room may have a laundry tub, water heater, water softener, and washing machine. Garden hoses connect to outdoor sill cocks, or faucets. Fixtures are made of vitreous china, porcelain enameled cast iron or steel, stainless steel, Monel metal, or cement. Faucets and drains of chrome-plated brass are common.

In the *water-supply system*, water flows from the street main or well to the fixtures. These lines are usually galvanized wrought iron or steel pipes, brass or copper pipes, copper tubing, or plastic pipes. Plumbing got its name from the Latin word *plumbum*, meaning "lead," at a time when pipes of this flexible metal were widely used in plumbing (*see* Lead).

Separate pipes convey hot and cold water. In most cities a water meter is installed so that a charge can be made for the amount of water used. Air chambers on water-supply pipes eliminate pounding noises when faucets are turned off (*see* Meters).

The *drainage system* is made up of drainage lines, traps, and vent lines. *Drainage lines* carry the discharge from fixtures to the street sewer, septic tank, or other disposal system. They are called stacks if vertical, and branches, if horizontal. Soil lines convey the discharge from water closets; waste lines carry discharge from other fixtures.

Drainage lines are of greater diameter than water-supply lines. They are made of cast iron, galvanized wrought iron or steel, concrete, copper, brass, asbestos cement, bituminized fiber, lead, or vitrified clay (*see* Brick). Water flows in drainage lines by gravity, whereas in water-supply lines it moves under pressure. Drainage pipes therefore must have the proper slope or pitch. Cleanout plugs in the lines permit remedying clogged pipes.

Traps for fixtures are drums, P-shaped elbows, or other devices, which retain some of the water flowing through them to form a water seal against the entrance of sewer gas into the house.

Vent lines keep injurious and offensive sewer gas from entering the house, equalize air pressure, and prevent breaking of the water seal in traps by siphonage (*see* Siphon). Vent stacks rise vertically and protrude through the roof of the house to the atmosphere outdoors.

The drainage system must be so designed that contaminated water cannot enter the water-supply pipes through a cross connection. Polluted water may flow back into the water-supply system if the water-supply opening is below the overflow level of a fixture. The amoebic dysentery epidemic in Chicago in 1933 during the Century of Progress Exposition was caused by poorly designed plumbing in a hotel.

Some codes require a separate storm-water drainage system for rain water from roofs, footings, and paved areas. Some also stipulate that water from the kitchen sink must pass through a grease trap or catch basin.

Common plumbing troubles include leaks in faucets, water closets, and pipes; freezing and clogging of pipes; and scale and corrosion from hard water.

PLUTARCH (about A.D. 42–120). No historian of ancient times has been more widely read or has had more influence than this keen-eyed essayist and biographer. Plutarch's 'Lives' has been called "the food of great souls" for its wealth of wisdom. Shakespeare drew the plots of several plays from its stories.

Plutarch was not a critical historian. He was interested primarily in character, and so he blended fact and legend into a tangle which only modern scholarship has been able to separate. Despite this defect, his biographies remain one of the foremost sources of information about classical antiquity.

The 'Parallel Lives of Illustrious Greeks and Romans' are written in pairs, and they contrast the careers and qualities of such men as Demosthenes and Cicero, Alexander and Caesar, Pericles and Fabius. Besides these, Plutarch wrote about 60 ethical essays, known as the 'Opera Moralia', discussing such subjects as "The Education of Children," "How to Get Benefits out of Enemies," "Advice to the Married."

Plutarch was born at Chaeronea in Boeotia, a district of Greece. He was educated in philosophy in Athens, and spent several years in Rome, where he lectured on philosophy and enjoyed the friendship of learned men. In his last days he was a magistrate and priest in his native city. He was sought after for his delightful and scholarly conversation, and a school gathered about him to listen to his lectures.

PLUTO. In Greek and Roman mythology Pluto was the god of the lower world. He was first called Hades ("the unseen") and was represented as pitiless and fear inspiring. Later his character changed and he became a beneficent god, bestowing blessings produced in the depths of the earth. His name was changed to Pluto ("giver of wealth"). When Zeus, Poseidon, and Hades cast lots for the kingdoms of heaven, the sea, and the infernal regions, the last fell to Hades. Here he ruled with his wife Persephone over the dead (*see* Hades).

PLUTONIUM. The third atomic bomb exploded was made from the metallic chemical element 94, plutonium. This superbomb destroyed Nagasaki in 1945 with an explosive force of 20,000 tons of TNT. Plutonium also has uses in peace—as fuel for atomic power plants and to produce radioactive isotopes for research.

Scientists long believed that only 92 elements existed (*see* Chemistry; Periodic Table). Then in 1934 Enrico Fermi, the Italian-born physicist, believed he had transmuted, or changed, element 92 (uranium) into elements 93 and 94 by bombarding its atoms with slow neutrons. Actually he had fissioned, or split, the uranium atom. The German scientists Otto Hahn and Fritz Strassmann established this in 1939.

The discovery of element 93 came in 1940 when Edwin M. McMillan and Philip H. Abelson bombarded uranium with neutrons in a cyclotron at the University of California. McMillan named this first man-made element *neptunium* (Np) after Neptune, the planet after Uranus in the solar system.

In the same year Glenn T. Seaborg, McMillan, and two associates bombarded an isotope, or variety, of uranium (U-238) with deuterons and changed it successively into U-239, neptunium (Np-239), and then into element 94 (*see* Atoms). Seaborg called it *plutonium* (Pu) for Pluto, the planet beyond Neptune. This element decays slowly, with a half life of 24,000 years. It is a bright metal and looks like uranium, nickel, or silver. It is hard and heavier than lead.

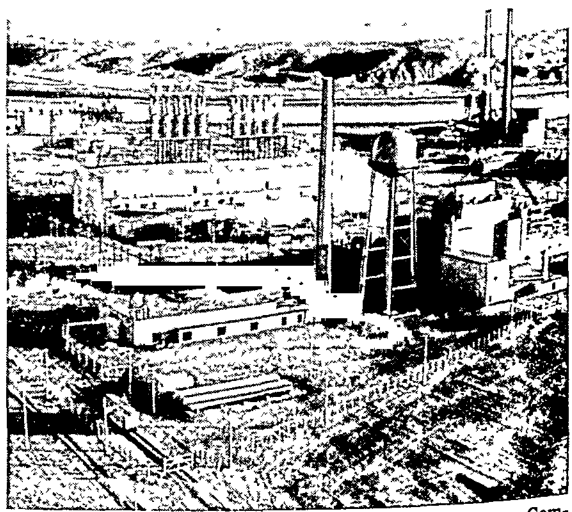
The plutonium isotope Pu-239, discovered in 1941 by Seaborg and his associates, is one of the few materials whose atoms will fission and sustain a chain reaction in an atomic bomb. The uranium isotopes U-233 and U-235 will also fission. U-233 is made from the element thorium, while U-235 makes up a small part of natural uranium, which consists largely of U-238 (*see* Uranium). The first two atom bombs were made from U-235. Plutonium, however, is more easily made from U-238 and is less costly.

Minute quantities of plutonium occur in uranium ores. Scientists manufactured the large amounts needed for the bomb in nuclear reactors. The first of these chain-reacting piles began operation at the University of Chicago in 1942. A pilot plutonium-producing plant at Oak Ridge, Tenn., was operating by 1943. A large-scale plant at Hanford, Wash., began work in 1944. The tremendous heat of its reactors is cooled by water from the Columbia River.

Industries can use the reactor's heat in power plants directly or by producing steam for turbines connected to electric generators. Reactors that produce more plutonium from U-238 than the amount of U-235 "burned," are called "breeders." The first breeder reactor was completed in 1953 at Arco, Idaho.

A useful by-product of reactors are radioactive isotopes (*see* Radioactivity). Elements are put into a pile and become radioactive by absorbing neutrons. These "tagged atoms" are used in research in basic science, agriculture, industry, biology, and medicine.

THE HANFORD PLUTONIUM PLANT



This is one of the production units of the Atomic Energy Commission's huge plutonium-producing plant at Hanford, Wash. It makes plutonium for atomic bombs or nuclear power plants.

PLYMOUTH, ENGLAND. The famous seaport from which the Pilgrim Fathers sailed in the *Mayflower* is the westernmost of England's Atlantic ports. It is at the head of Plymouth Sound in southwest Devonshire, a section of England noted for its gardens, hedges, beautiful green fields, and quiet country lanes. The city gets its name from the River Plym, at whose mouth it lies.

Beginning in the 1500's, Plymouth was for centuries the home port for many of the expeditions which made England the greatest of maritime nations. Sir Francis Drake left from this port on his world voyage of 1577–80. Hawkins, Raleigh, and Frobisher are other memorable names in the town's annals. From here in 1588 the English fleet sailed to meet the approaching Armada of Spain. Almost two centuries later, in 1772 and 1776, Capt. James Cook sailed from Plymouth on his voyages of exploration.

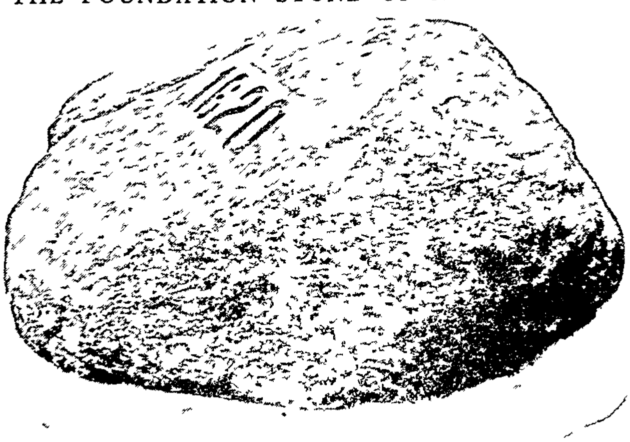
The city today is a busy commercial port, naval station, and aviation base. It handles a considerable part of England's transatlantic trade. Its fisheries are important. In its Marine Biological Laboratory significant research has been done.

In the second World War Plymouth was a strategic point because of its imports and because of its great docks and shipyards. Hence it was subjected to intense air raids by the Germans and suffered heavy losses of life and property. Even the commemoration stone marking the sailing of the *Mayflower* was damaged. Population (1951 census, preliminary), 208,985.

"A BAND *of* EXILES *on the Wild New England Shore*"

PLYMOUTH, MASS. Pilgrim leaders chose Plymouth for their home because it had a broad, sheltered harbor, a large brook of "sweet" water, wooded hills to supply timber, and stretches of cleared ground. They landed there Dec. 21, 1620 (December 11 old style), guided by a map made by Capt. John Smith. He had named the spot in honor of Plymouth, England—the very harbor from which they had sailed on the *Mayflower* nearly 14 weeks earlier (*see* 'Mayflower').

THE FOUNDATION STONE OF NEW ENGLAND



According to tradition, the Pilgrims stepped on this rock when they landed at Plymouth but some historians doubt it. The first to land was an exploring party sent from the *Mayflower*, lying off Cape Cod. The rock is protected by a granite canopy erected in 1920, on the 300th anniversary of the landing.

The settlers were Separatists from England who came to the New World to secure freedom of worship. They gave thanks and rejoiced that their long, hard voyage was over; but greater hardships lay ahead. The cruel New England winter chilled a people already weakened by exposure and poor diet. While they were building small dwellings and a storehouse, they had to row through the icy surf to their crowded quarters on the tossing *Mayflower*. The store of food was low. The Pilgrims were not skilled at hunting and fishing or equipped with sea-fishing boats and gear.

The "general sickness" soon struck. With symptoms of scurvy and pneumonia it spread through the colony. At times there were no more than six or seven well persons to care for the others. Two of these were devout Elder William Brewster and bluff Miles Standish, the military leader. Before the winter ended, half of the members of the Pilgrim band had died. The women suffered most. Of 18 wives, only four lived. Of 18 husbands, eight were left. Among the 51 who died was Gov. John Carver. His successor was William Bradford. Under his wise and devoted leadership, the colony survived. The Pilgrim Fathers feared to let the Indians know how greatly their numbers were reduced. They buried the dead at night and leveled the ground to conceal the graves.

How the Indians Helped

The settlers were fortunate in their relations with the Indians. No tribe lived in or near Plymouth. The Patuxet Indians who had lived in the area had been wiped out by smallpox four years earlier and cleared fields lay vacant. The neighboring Indians proved friendly. Samoset and Squanto, two of their first friends, had learned to speak English from explorers and could act as interpreters.

Samoset arranged a meeting with powerful Massasoit, sachem (chief) of the Wampanoags, and a treaty of peace was signed. It was never broken by either side so long as any of the signers lived. Massasoit proved a loyal friend. He notified the Pilgrims when other tribes threatened to attack. One day a Narragansett brave came bearing the skin of a rattlesnake bound around a bunch of arrows as a challenge to war. Governor Bradford returned the skin filled with bullets, and the Indians abandoned the attack.

Squanto, or Tisquantum, had been captured by the crew of an English vessel and sold as a slave in Spain. He escaped to England and returned on an exploring ship. He and another Indian, Hobomok, made their homes in Plymouth. They taught the colonists to plant corn and to catch herring for fertilizer by using a weir, or trap, in Town Brook. When the 1621 harvest was bountiful, the Pilgrims held their first Thanksgiving feast (*see* Thanksgiving).

LEYDEN STREET, PLYMOUTH, IN 1627

The Pilgrims soon replaced their first temporary shelters with neat frame houses, like those of their English homeland. The tradition that they built log houses is proved false in 'The Log Cabin Myth' by H. R. Shurtleff, from which this illustration is reproduced (courtesy Harvard University Press).

They invited Massasoit, who came with 90 braves. Fortunately the Indian hunters brought along five deer.

The Pilgrims were handicapped by their contract with the London merchant adventurers who had supplied the money for the voyage to America. No settler could work for his own gain. All they produced had to be placed in a common store. From it the people were given food and other necessities. When they traded with the Indians or cut and sawed timber, they had to ship the furs and lumber to London. The merchants were slow in forwarding supplies. Sometimes they sent over settlers who brought no provisions and had to be fed from the scanty stores. The Pilgrims went through many hungry seasons.

Land was granted to each settler in 1627. Then each man had a reason to work hard and provide for his own family. The crops improved. The same year Governor Bradford and other leaders bought out the English merchants by an agreement to pay off the colony's debts in return for the right to trade with the Indians. Trading posts were built as far away as the Connecticut Valley and the region now called Maine.

Plymouth's most prosperous days came between 1630 and 1640 when the neighboring Massachusetts Bay colony attracted about 16,000 colonists. The Puritans found a ready market for their corn, livestock, and other provisions. This prosperity led to the weakening of the tight-knit religious colony. The families began *moving to find pasture for their stock.* Plymouth shrank in size and in influence. In 1692 it was absorbed by Massachusetts when that colony obtained a new charter from the English king.

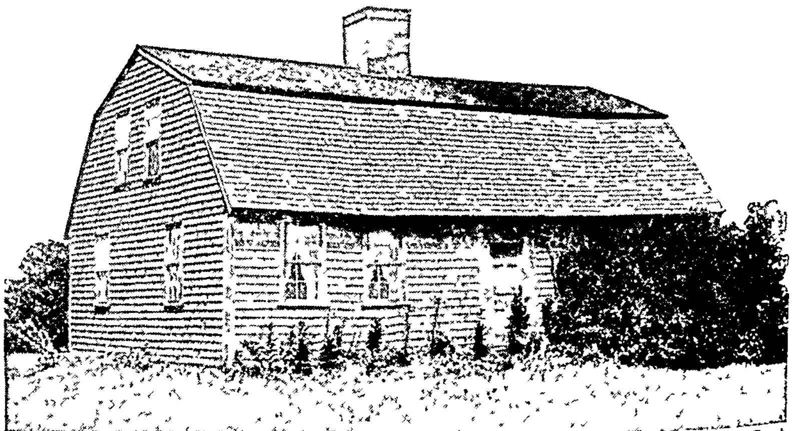
Plymouth Today

The visitor to modern Plymouth finds many reminders of the past. On the water front is famous Plymouth Rock under a granite canopy. Here, according to tradition, the first Pilgrims stepped ashore. Back of the Rock on Cole's Hill, where the dead had been secretly buried, stands a statue of Massasoit. None of the original houses remain along Leyden Street; but on nearby streets there are five which were built later in the 1600's and several erected in the 18th century.

In Pilgrim Hall, erected by the Pilgrim Society in 1824, are the patent of Plymouth Colony, granted by the Council for New England in 1621; the chairs of Elder Brewster and Governor Carver; the cradle of Peregrine White, first white child born in New England; the Bible of Governor Bradford, printed 1592; and the sword of Miles Standish. A National Monument to the Forefathers is in northwest Plymouth.

On Burial Hill, where the old fort was built in the summer of 1622, stands a reproduction of the powder house. The main floor of the fort was used as a meetinghouse, and cannon were mounted on the roof. A project to build reproductions of the old fort, a typical dwelling, and the *Mayflower* was started in 1947. Sponsors were Plimouth Plantation, Inc., a

THE STANDISH HOUSE IN DUXBURY



The growing settlement at Plymouth soon needed additional land, and in 1631 Capt. Miles Standish and John Alden founded Duxbury, a few miles to the north. This two-story frame house was built in 1666 by Alexander Standish, son of the famous soldier-colonist. Some of its timbers are from the captain's original dwelling, which had burned. Note the gambrel roof, which was used in many New England buildings.

ALONE IN THE NEW WORLD

As the *Mayflower* sets sail for its return voyage in April 1621, the Pilgrims stand on the New England shore. Some watch the little ship disappear toward the horizon. Others pray, each in his own way, for Divine help. They already know something of the bitter hardship to be faced in the new land, but they are firm in their resolve to stay and conquer this wilderness.

nonprofit society that adopted the spelling used by Governor Bradford.

Ropemaking was among the earliest of Plymouth's industries, and the town still has one of the world's largest cordage works. Other manufactures are insulated wire, tacks, high-grade woolens, and curtains. The country is a leading producer of cranberries. The city has a considerable tourist business. Population (1950 census), city, 10,540; township, 13,652.

PLYWOOD. Layers of thinly sliced wood glued together form plywood. The grain of each ply runs at an angle to the grain of its neighbors. This cross-graining equalizes the strength along the length and width, equalizes expansion and contraction, and prevents splitting. When three plies are used, the outside sheets are called *faces* and the inside piece is called the *core*. When five or more plies are used, the intervening layers are called *crossbands*.

The use of plywood dates back to 1500 B.C. But it did not become widely used until modern methods of production were introduced. Previously the plies were cut from the flat surface of a split log, and no plies wider than the log itself could be produced. Today a smooth log, called a *peeler* log, is revolved in a huge lathe against a long cutter blade. This shaves off a continuous sheet of wood, much as paper is unwound from a roll. Any desired thickness from a fourth to a fortieth of an inch can be obtained.

The sheets are then cut to size, and the required number are bonded together. Modern methods of manufacture use synthetic plastics instead of the older types of glue. Among the plastics used are the phenolformaldehyde and the urea resins (*see* Plastics). Some plastic-bonded plywoods withstand continuous soaking in water without coming apart.

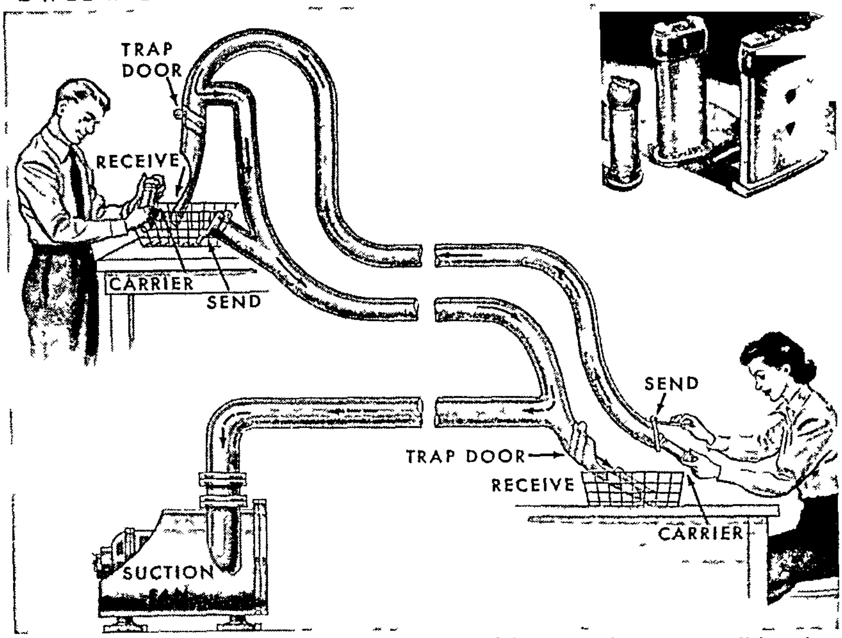
Even tougher than these are the plywoods permeated with heat-setting plastics. The plies are impregnated with the plastic, then pressed together and heated. They unite to form a material stronger per pound of weight than steel. These are sometimes called by the trade names *compreg* and *impreg*.

When curved surfaces are required, strips of impregnated layers are shaped around forms and set by heat and pressure. Airplane fuselages, wings, and control surfaces are often made in this way. Their light weight and their glasslike finish, free from joints and rivets, enable the plane to use less power in flight. They are also said to be safer, for plywood, unlike metal, does not break when subjected to repeated bending or continual vibration.

Many prefabricated buildings are constructed almost wholly of plywood, with plastic-bonded woods for the exterior and ordinary plywood for interior work. Beautiful paneling, furniture, cabinets, and pianos are made of plywood, with veneers of fine-grained hardwood for the outer surface (*see* Veneer).

Laminated wood is made by gluing two or more strips with their grains running roughly parallel. A piece of laminated wood is no stronger than a piece of solid wood of the same size and kind, but its strength is distributed more uniformly and is less likely to be affected by the moisture content of the air. Laminated wood is especially suitable for roof beams and arches, either curved or straight.

SWIFT PASSAGE THROUGH PNEUMATIC TUBES



In this pneumatic tube system carriers are whisked from "send" to "receive" in a few seconds. The exhaust fan creates a partial vacuum, and incoming air at "send" pushes the carrier along. Various carriers are shown in the inset above.

PNEUMATIC APPLIANCES. The devices that harness the power of air and make it perform useful work are called *pneumatic appliances.* "Pneumatic" comes from a Greek word *pneuma,* meaning "air" or "wind."

In these appliances air is put to work in one of several ways. One important method makes use of the fact that when air is withdrawn from one end of a tube, more air will rush in from the other end to take its place. The rush of air through the tube can push or carry a load with it. Another important method makes use of the force exerted by the expansion of compressed air.

An example of the first method is the action in a vacuum cleaner. Here a suction fan creates the rush of air that carries dirt from the floor into the cleaner bag. The vacuum cleaner is somewhat misnamed. It creates only a partial vacuum which is being continuously filled by the inrushing air.

How the Pneumatic Tube System Works

Another device for making the rush of air perform work is a pneumatic tube system. The moving air transports a cylindrical *carrier* from one station to another, as shown in the picture above. Enclosed in the carrier may be papers, letters, books, and even such relatively weighty objects as small tools. In this system, an exhaust fan keeps air withdrawn from the tubes. When the operator opens one end to insert the carrier, enough air enters to push the carrier along. Some systems use compressed air instead to drive the carrier.

Pneumatic tube systems are installed in stores to transmit money from clerk to cashier and to return change and receipts. Offices use them to send papers between departments, and factories use them to send small tools from storerooms to shops. On newspapers, where speed is essential, copy is sent from the editors to the printers with pneumatic tubes.

In some cities, long tubes are laid under the streets to carry mail between post offices or from post offices to railway stations. In a three-inch tube, for example, a loaded carrier can travel 1,000 yards a minute under a ten-pound air pressure. Speed of other carriers varies with the diameter of the tube, the size of the load, and the pressure used.

USING COMPRESSED AIR FOR POWER

This worker is ripping up street pavement with a *paving breaker.* The diagram on the opposite page shows how the tool works.

Uses for Compressed Air

When air is compressed into an enclosed container, it exerts a force on the container walls. One of the most familiar examples of this is the automobile tire. Here the air keeps the tire inflated and acts as a cushion to absorb the shocks and jolts imparted by the uneven street or road surface.

The force of air under compression can be released as a continuous blast. Many different devices use such an air blast for power. The compressed air may come from a tank or be supplied at the scene of work by a motor-driven air compressor.

Air blasts are used to drive a great variety of pneumatic tools, such as drills, wrenches, hammers, chisels, spades, and tampers. One of the most spectacular—as well as one of the noisiest—of these tools is the *paving breaker,* shown in the picture on this page. This tool rips its way through asphalt, brick, or concrete, gouging out great chunks of material by the force of the air pressure which is behind it.

In these tools, the compressed air is applied to each end of a

piston in turn, as shown in the diagrams on this page. Pressure at one end drives the piston against the base of the tool, and alternate pressure at the other pushes the piston back to its starting position. The moving piston itself opens and closes the ports that admit the compressed air into the piston cylinder. The action of the piston is so swift that some of these tools can deliver several thousand blows a minute.

Spray Guns and Other Pneumatic Devices

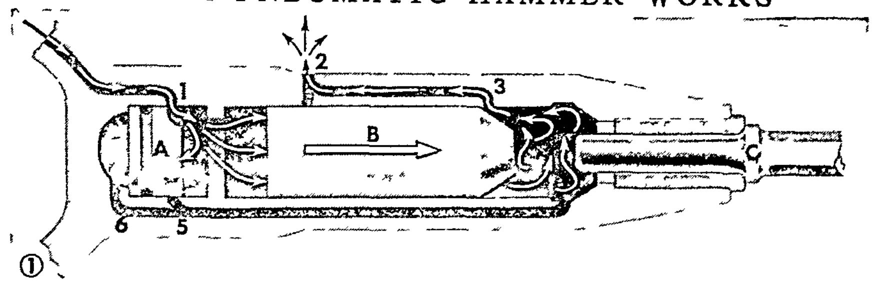
If you blow across the surface of a dish of water, the blast *carries off a quantity of water* in a fine spray. This action is used in devices called *spray guns* for applying paints or spraying liquids. A blast of compressed air crosses the liquid and a nozzle directs the spray. In a common insecticide spray, the action of the plunger compresses the air. Paint and cement are often applied to surfaces by this method. A sandblast can be directed against the sides of a building to scour off the grime and dirt.

Artists use a similar device called an *airbrush*. This sprays pigments on the drawing paper much more evenly and with finer gradations of tone than are possible with the strokes of an ordinary brush.

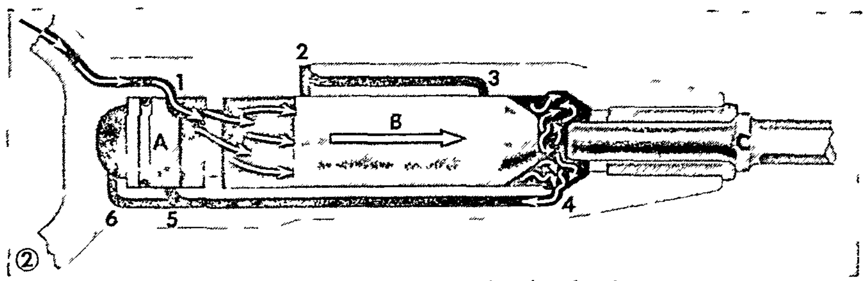
In pneumatic presses the compressed air is applied to a plunger that drives the pressing surface down. Other devices employ an air-driven motor geared to the working tool. Locomotives driven by compressed air are often used in mines, *munitions factories, and* other places where steam or electric locomotives would be dangerous or undesirable.

When compressed air is driven into a water-filled tunnel or into an inverted cuplike chamber under water, the pressure of the air will keep the water out and provide a space in which men can work. Compressed air is often used in this way for driving tunnels and foundations through watery soil, under rivers, and in making foun-

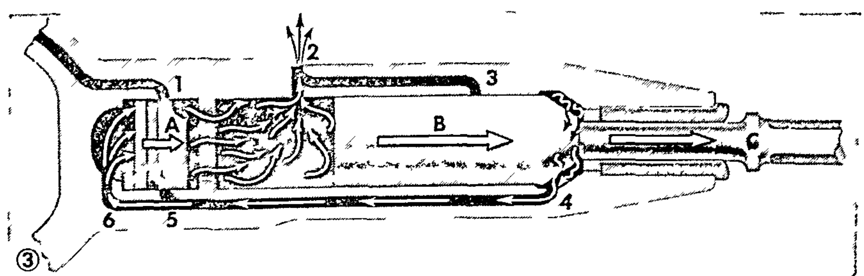
HOW A PNEUMATIC HAMMER WORKS



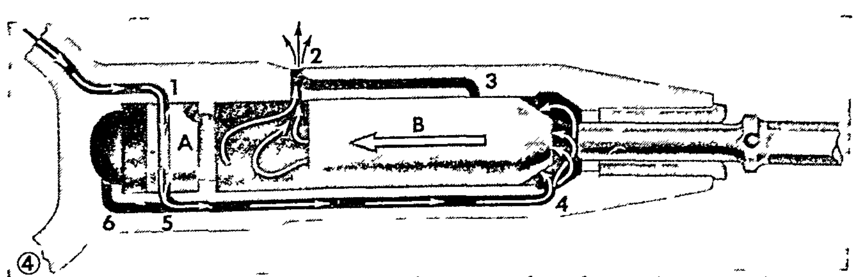
These diagrams show step by step how a pneumatic tool uses compressed air to drive a toolhead such as a hammer or chisel. The moving parts are a valve (A), a piston (B), and the toolhead itself (C). The compressed air drives the piston back and forth to make the tool work. The different movements are shown step by step in the diagrams. Here compressed air enters from the tool handle through port 1 and drives the piston forward. The forward motion pushes air out through port 3.



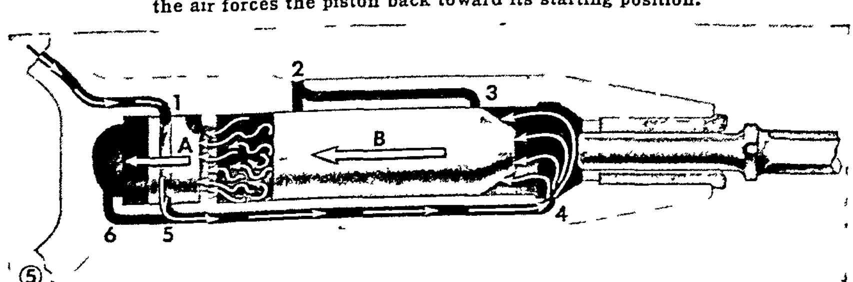
The piston moves forward and blocks ports 2 and 3. Air ahead of the piston compresses slightly and escapes through port 4. It starts on its way back to port 6 to begin the work of pushing the valve forward, as shown in the next step.



Here the piston drives the toolhead forward and the power stroke is complete. Air from port 6 begins to push the valve forward. This temporarily closes port 1. Air between valve and piston escapes through port 2.



Now the valve is in its forward position. Air comes through port 1, passes through a channel in the valve into port 5, then passes forward. Entering the chamber at port 4, the air forces the piston back toward its starting position.



Compressed air acting through port 4 forces the piston back and closes ports 2 and 3. Air caught between the forward face of the valve and the moving piston forces the valve back to its starting position. The tool is now ready for another blow.

dations for structures such as lighthouses and bridges. (*See also* Tunnels and Subways.)

Pneumatics is the name sometimes given to the branch of physics that treats of the mechanical properties of air and other gases. These include their behavior when set in motion and their elasticity and density. It includes also the practical application of these properties in devices and machines such as those discussed in this article. (*See also* Air; Gas.)

PO. Italy's largest river, the Po, rises high in the Cottian Alps on the extreme western border. The Po is a mountain torrent fed by the "aged snows" of the Alps and by tributary streams. In the first stage of its 420-mile course to the sea it falls more than 5,200 feet in only 21 miles. It widens to 425 feet as it nears the busy city of Turin and moves more slowly. At last, winding sluggishly across what has been described as "fruitful Lombardy, the pleasant garden of great Italy," the Po finds its way through its huge delta into the Adriatic.

Fine sediment carried from the Alps and from the Apennines increases the area of the delta at the river's mouth about 175 acres every year. Some towns once on the coast are now several miles inland. The sediment also builds up the river bed. In many places the bed is above the level of the surrounding country. Many dikes have been built from Cremona to the delta, some of them of unknown antiquity. Despite the dikes, floods often prove disastrous.

The Po discharges a volume of water almost equal to that of the Rhine. Because of its great volume and width it is a hard river to cross. Thus its commercial cities such as Piacenza and Turin are found where there are the easiest fords. The river teems with salmon, shad, sturgeon, and other fish as it flows through Piedmont, Lombardy, and the southern edge of Venetia. It has a drainage basin covering most of northern Italy. Much of Italy's grain, sugar beets, hemp, and cattle is raised in the Po basin.

POCAHONTAS PLEADS FOR JOHN SMITH'S LIFE

According to Capt. John Smith, Powhatan's warriors were about to club him to death. Pocahontas dashed forward, threw herself between Smith and his executioners, and begged her father to spare the Englishman. Smith did not tell this story until 15 years after his return to England.

POCAHONTAS (1595?–1617). A thrilling story of early settlement in America tells how Pocahontas, daughter of the chief Powhatan, saved the life of Capt. John Smith. Powhatan's warriors had captured Smith and were about to put him to death when Pocahontas pleaded with her father to spare him. Powhatan did so and Smith was allowed to go free.

Many historians doubt that the incident took place. Smith himself did not mention it in his first published account of Virginia, although he did tell of Pocahontas' visits to Jamestown (*see* Smith). Only much later did he include the story in his 'Generall Historie of Virginia'. But it is undoubtedly true that Pocahontas helped bring peace between her people and the early Jamestown settlers.

Pocahontas was a younger daughter of Powhatan, chief of a tribe of Algonquian Indians who lived in the tidewater region of Virginia. Her real name was Matoaka. The name Pocahontas means "playful one." She often visited Jamestown and the settlers thought her a very pretty young girl.

As she grew older, Pocahontas often brought food to the near-starving settlement She also warned

the colonists of proposed Indian attacks. While still in her early teens Pocahontas went to visit with a friendly tribe on the banks of the Rappahannock River. In the spring of 1613, Capt. Samuel Argall was trading for corn along the river and learned that she was near by. Either by bribery or threats he induced the Indians to turn the girl over to him. Argall took Pocahontas to Jamestown as a hostage.

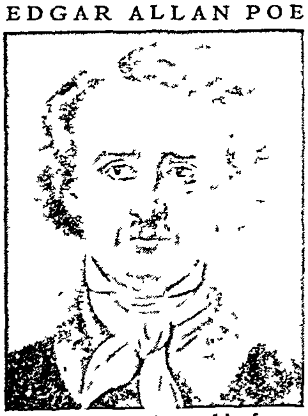
The Jamestown settlers treated Pocahontas kindly. They converted her to Christianity and baptized her with the name Rebecca. At Jamestown she met John Rolfe, a young widower. He was noted as the first colonist to grow tobacco as a crop. In 1614 Rolfe requested permission to marry Pocahontas. Governor Thomas Dale readily agreed. Powhatan also was pleased by the proposal and sent an envoy to the wedding. They were married April 5, 1614, in the Episcopal church at Jamestown. Their marriage brought an eight-year peace with the Indians. This gave the colonists time to get firmly established.

In 1615 the Rolfes' only child, Thomas, was born. The next year the family, with several Indian attendants, sailed to England for a visit. The English were very kind to Pocahontas. The king and queen received her at the palace and the Bishop of London entertained her. She also renewed her acquaintance with Captain Smith, who had returned to England in 1609. During her stay in London, Smith revised the earlier version of his Virginia experiences to include the rescue story. In 1617 the Rolfes prepared to return to Virginia. Before they sailed, Pocahontas died of a fever. She was buried in St. George's Church, Gravesend. (There a chapel was dedicated to her in 1952.) Her son was reared in England. In 1640 he returned to Virginia and married. Through him, many Americans trace their lineage to Pocahontas.

POE—*Unhappy* GENIUS *of* LITERATURE

POE, EDGAR ALLAN (1809–1849). Everyone likes a thrilling "ghost" story, filled with mystery and excitement. The greatest American teller of such tales was Edgar Allan Poe. He wrote of men trapped in a haunted, crumbling mansion or caught between a yawning pit and a swinging pendulum knife. He also wrote of mysteries solved by clever deduction—the first modern detective stories. Poe's poems, like his tales, are of men tortured by nameless fears and longings. Today Poe is acclaimed one of America's greatest writers; but in his own unhappy lifetime he knew little but failure.

EDGAR ALLAN POE



Poe's fame rests on his fascinating short stories and poems.

Poe's parents were touring actors. The boy was born in Boston, Mass., Jan. 19, 1809. Orphaned at three, he was taken into the home of John Allan, a merchant of Richmond, Va. Mrs. Allan had no children and she reared Edgar as her son. John Allan accepted him largely to please his wife. Later Poe took Allan as his middle name, but his signature was usually "Edgar A. Poe."

Even as a boy Poe was moody and changeable. At times he enjoyed swimming, hunting, and games. When he was 15 he swam six miles in the James River against the tide. He was a lieutenant in a junior militia corps. But often he would take solitary walks in the woods or lock himself in his room to write verses. When the young mother of a playmate died, Poe was depressed for months. Later he created an idealized portrait of her in his poem 'To Helen'.

John Allan became one of the richest men in Virginia. He never formally adopted Poe, but the boy thought that he would be named Allan's heir. After a time, however, Allan grew cold toward him and Poe realized that his place in the family was insecure.

When he was 17 Poe entered the University of Virginia. Allan gave Poe only a small allowance, and the young man soon began owing money. He gambled and ran into greater debt. By the end of the year he owed $2,500. He was nervous and unstable and he began to drink. His body could not tolerate alcohol, and only a very little made him first intoxicated and later ill. Allan angrily withdrew Poe from school, and a few months later Poe left home.

Poe came to Boston with some early poems. He persuaded a printer to make them up in a small pamphlet. It was called 'Tamerlane and Other Poems' and the title page bore simply: "By a Bostonian." Poe's money was soon gone and he enlisted in the army under the name of Edgar A. Perry. Army records show he was five feet, eight inches tall, with gray eyes and brown hair. Poe was a good soldier. In his two years in the army he rose to be regimental sergeant major. But he wanted to become an officer, thinking that such advancement would restore him to Allan's favor. Granted an honorable discharge, he sought an appointment to West Point.

Poe waited for more than a year. Meantime he lived in Baltimore with his father's widowed sister, Mrs. Maria Clemm, and her young daughter, Virginia. On July 1, 1830, Poe was sworn in as a cadet. He hated the discipline and the restraint. Mrs. Allan had died in 1829, and when John Allan married again Poe lost all chance of becoming his heir. He deliberately neglected classes and duties and was expelled after eight months.

For the next four years Poe struggled to earn a living as a writer. He returned to Mrs. Clemm's home and submitted stories to magazines. Finally in 1835 he joined the staff of the *Southern Literary Messenger* and took out a license to marry his cousin Virginia. After they were married, Mrs. Clemm stayed with them. The Poes had no children.

POE CONCENTRATES ON A MASTERPIECE

At their Fordham cottage Poe often wrote until late at night. His young wife, Virginia, often stayed up with him, even though at the last she was weak and deathly ill. Poe worked by fits and starts; but once a story or poem was well launched he could finish it in a few days.

Poe's stories, poems, and reviews in the magazine soon attracted attention, and he looked for wider opportunities. From 1837 to 1839 he tried free-lance writing in New York City and Philadelphia, but earned very little. Again he tried editing (1839–42). His work was praised, but he was paid little. He tried to organize his own magazine but failed. For the next two years he turned again to free-lance writing.

Many of his best stories were written as a regular part of his editorial work. Even those he sold for a fee rarely brought him more than $100 each. Some of these were: 'Narrative of Arthur Gordon Pym' (1838); 'Fall of the House of Usher' (1839); 'Murders in the Rue Morgue' (1843); and 'The Gold Bug' (1843). During this time Virginia showed symptoms of tuberculosis.

In 1844 Poe and his family moved to New York City. By now Poe was well known in literary circles, and the publication of 'The Raven' in 1845 enhanced his reputation. The Poes lived in a cottage in Fordham (now in the borough of the Bronx, New York City). They were comfortable for a time. But Virginia became sicker, and Poe grew weaker and became more dissipated. During the winter of 1846–47 they had little food or fuel. Virginia died Jan. 30, 1847.

After his wife's death Poe continued to live with Mrs. Clemm at Fordham. By now he was increasingly depressed and erratic. He courted various women, trying to find solace for the loss of Virginia. In 1849 he became engaged to a childhood sweetheart, who then was a wealthy Richmond widow. After making wedding plans, he started to New York City from Richmond, but disappeared in Baltimore for five days. It was near election time, and it is very probable that he was kidnaped by a gang which was supplying fraudulent votes. He was found on election day, drugged, intoxicated, and very near death. He died without regaining full consciousness four days later, Oct. 7, 1849.

During his last years Poe was recognized as a genius. Since then his reputation in literature has been secure (*see* American Literature). In France he is the best known American writer.

POET LAUREATE. In ancient Greece the laurel tree was considered sacred to the god Apollo, patron of poets. Hence poets who won distinction were crowned with a wreath of laurel. Later the same practise was followed in Italy. Petrarch and Tasso received this honor. In time the word "laureate," which meant originally "crowned with laurel," came to mean "honored" or "eminent."

The title "poet laureate" is given in England to a poet attached to the royal household. From very early times the English kings included poets or minstrels in their retinue. Instead of being crowned with laurel, however, the poets received pensions from the king. Edward III gave such a pension, together with a pitcher of wine daily, to Geoffrey Chaucer. Queen Elizabeth I honored Edmund Spenser in a similar manner. James I created the office of court poet for Ben Jonson in 1617. Sir William Davenant succeeded Jonson in 1638 and held the office until his death in 1668. John Dryden was the first to receive the official title of poet laureate; he held it from 1670 to 1700. Today the poet laureate receives approximately £100 a year.

Dryden's successors, and their terms of office, have been Thomas Shadwell, 1688–92; Nahum Tate, 1692–1715; Nicholas Rowe, 1715–18; Laurence Eusden, 1718–30; Colley Cibber, 1730–57; William Whitehead, 1757–85; Thomas Warton, 1785–90; Henry James Pye, 1790–1813; Southey, 1813–43; Wordsworth, 1843–50; Tennyson, 1850–92; Alfred Austin, 1896–1913; Robert Bridges, 1913–30; John Masefield, 1930–

The MAGIC *of* POETRY *and the* POET'S ART

How the Music of Verse Is Made by Rhyme, Meter, and Pattern

POETRY. Poetry is one of the oldest of the arts and one of the most persistent. We do not know who the first person was who had the idea of telling a story or expressing a thought in rhythmic, chanting words with a strong and easily remembered beat. Perhaps he thudded a drum-log by some very early campfire and, as he thought of his day's hunting or the fearfulness of the night or his own bravery, began to fit words to the rough tune. He would chant and stamp and beat as he made those words. Where the words did not fill out the tune, he would give a shout or a cry. That must have been the earliest and most primitive form of poetry—rhythmic words, chanted aloud to a rough musical accompaniment or to no accompaniment at all but the stamp of the chanter's feet on the ground, the slap of his hands on his body to mark the pulse of the song.

He was saying something, but he was singing it as well; he was making his words a drum-beat or the rush of a storm, a prayer or a call to battle. If he had merely wanted to tell his friends that he was hungry or that he had seen a fine herd of deer in the forest, he would not have needed the drum or the cry or the chant. He would have said what he had to say in prose, as we do when we write an ordinary letter about ordinary things. But he wanted to do more than that. He wanted his friends to remember what he said and to think about it. He wanted to excite and stir them as he was excited and stirred. So he made a song, in words.

Then, if people liked the song, they would listen. A very famous song might be passed down and down through the generations by word of mouth, until there got to be something sacred about it. Till, at last, poems were written down—and Alexander the Great, as he strove to conquer the world, carried Homer's 'Iliad' about with him in a gold casket; and James Wolfe, the great British general, told his council, on the eve of victory, that he would rather have written Gray's 'Elegy' than capture Quebec. For that is the way that great men and great nations have felt about great poetry. They have thought of it not as a task or an ornament, but as an essential part of the greatness of life.

The Poet's Purpose

It is a long way from the chanting singer, in the red light of the campfire, to the printed book of verse in your library. But the road is a clear one, and the poet's intent the same. He is trying to tell you something—perhaps a story about gods or heroes, about lumberjacks or sailors or the people you meet every day—perhaps merely about his own feelings when he sees a cloud or a flower—perhaps about the mysterious things of life, the things like death and birth and the great empty places between the stars which make us feel small and wondering when we stand before them. But he is trying to tell it to you rhythmically, in musical words that will stir your imagination and leave a magic pattern on your mind. Most people talk a great deal but say very little; the poet tries to talk very little but say a great deal. He wants to make you see what he has seen and feel what he has felt. To do so, he uses words not only for their meaning but for their ring and music—as a composer uses the sound of certain musical instruments, alone or in combination, when he wishes to make you think of the sea or the forest, of the trumpets of battle or the voices of lovers at night.

The Music in Primitive Poetry

We know what primitive poetry is like; we have very fine examples of it in the ceremonial chants of our own North American Indians. When the Indian singer chants, in his own language, to the drum-beat

> The corn grows by the red rock.
> Beautifully it grows

he could hardly make a plainer or more simple song. In the English translation we miss the drum-beat, we miss the music of the Indian words for corn and rock and the rest. But we notice this: In the first place, the singer has seen something beautiful, something he wishes to share with his fellows. To do so, he does not merely make a direct statement, "I saw six fine ears of corn growing by a red rock." He repeats words for their sound, he arranges a musical pattern of words to fit his idea. So we get the beginnings of poetry.

When we reach a slightly more civilized form of poetry—the poetry of the ballads of the Scottish Border, for instance—we still hear the musical accompaniment with the words:

> Ye Hielands and ye Lowlands,
> O where hae ye been?
> They hae slain the Earl of Murray
> And laid him on the green.

We can hear the harper harping the notes and the voice singing. Indeed, this poem has been set to music many times. But the music is in the words as well. Rearrange the words in another way: "Where have you been, Highlands and Lowlands? His enemies have killed the Earl of Murray and laid him on the greensward." The sense is the same, but most of the music has gone. And, with the music, has gone another quality, that of intensity. The first passage, somehow, is not only more musical but more exciting than the second. And intensity, excitement, a keying-up of the mind as the body is keyed to a sudden spurt in a race, is one of the qualities of poetry.

Poetry is beat and rhythm and dance. It does not walk. It runs, skips, soars, flies. It can move as massively as a great ship down the launching-ways; it can move as delicately and subtly as the wind through a field of grass.

> When Ajax strives some rock's vast weight to throw,
> The line, too, labours, and the words move slow.

And when

> High on a throne of royal state, which far
> Outshone the wealth of Ormus and of Ind . . .
> Satan exalted sate, . . .

the rich, slow, ponderous words build up the portentous majesty of that evil throne. But when

> All the girls are out with their baskets for the primrose;
> Up lanes, woods through, they troop in joyful bands.—

the whole verse sparkles and dances. You could not say it slowly and gloomily if you wished. There is in it the light-footed hurry of a joyful throng.

It is natural that it should be so. For poetry is primarily a rhythmic thing. In books, as in all writing, it consists of words printed on a page. But these words are meant to be heard with the ear as well as read by the eye. Unless you can find and listen to the rhythm of the words of a poem, you are missing half the poem.

How is poetry written? How "out of three sounds" does the poet make "not a fourth sound, but a star"? Each language and each literature has its own ways. Greek poetry, for instance, was based not upon rhyme but upon beat—upon the beat of certain meters (line lengths), like the surge of waves on a beach—and the ebb and flow of syllables in the individual lines which gave variation to the master beat. English poetry has been strongly rhyming, although it has employed many unrhymed forms, notably blank verse and free verse (*vers libre*). Each poetry has developed certain rules, certain forms or molds, certain meters which seemed to bring out the most musical and imaginative qualities of its own language.

Certain forms die, are revived, and die again. Certain ways of writing poetry are employed by one age, scorned by another, reworked perhaps by a third. Cultivated Frenchmen of the Eighteenth Century, used to the stately classicism of Corneille and Racine, found Shakespeare's work crude, barbarous, and violent. They thought of him as some of our own conventional critics thought of Walt Whitman—the sort of person you shouldn't let into your house because he might wipe his muddy feet on your best carpets. On the other hand, to many of us who are used to English poetry, reading Corneille and Racine is rather like wandering through a vast marble colonnade. We know that it is great, but we miss, in its cool perfection, the warmth, the intimacy, and the color of our own verse. And it is so even among works in the same language. You may like one sort of poetry very much and dislike another extremely. You may, for instance, think 'Paradise Lost' a dull and tedious affair and 'The Highwayman' an exciting adventure. But, before you shut any kind of poetry out of your mind, it is a good thing to see what the poet has tried to do and what sort of tools he has used to build his poem.

A poem must be imaginative enough to stir your own imagination. That is its first necessity; and if it does not do that to you as a reader, it is not a poem for you. It may be a very good poem to another reader whose mind, so to speak, tunes in on a different wave-length from yours—but that is another matter.

What tools does the poet use to make his rhythmic pattern, the pattern with which he hopes to stir your imagination? He has three chief tools—rhyme, meter, and pattern. He uses them in various combinations.

Rhyme

Let us start with the simplest tool, the one most familiar to us—rhyme. What is a rhyme? A rhyme is a pair of words which end with the same sound but begin differently.

> Hickory dickory dock.
> The mouse ran up the clock.

Dock and *clock* are rhymes. So are *Mary* and *contrary*, *Horner* and *corner*, *pail*, *whale*, and *sail*, and thousands more. But *soar* and *sore* are not rhymes. They are spelled differently, but the sound is identical; both the beginning- and end-sounds are the same.

In words of more than one syllable, the rhyme must be where the emphasis is. Thus *ailing* and *failing* are rhymes, because the emphasis on each word is on *ail* and *fail*. But *ailing* and *thing* are not true rhymes, as the emphasis in *ailing* is on the *ail* sound and the emphasis in *thing* is on the *ing* sound. Rhymes, in general, should rhyme to the ear, not to the eye, although in English there is a certain limited class of words that rhyme to the eye and not to the ear—*wind* (as we now pronounce it) and *blind*, for example, or *loving* and *roving*—which usage has made allowable.

And, in modern poetry, particularly, you will find a great deal of assonance—of words like *shadow* and *meadow* with similar but not identical sounds.

> Suppose, when you're lonely,
> There's nought in your kettles
> But bread broken stonily
> And serpentish victuals

says Elinor Wylie, in her beautiful 'Grace Before Meat'. Here all four rhymes are assonantal.

But in general the person who is beginning to write poetry—not the expert—should try to make his rhymes as clear and true as possible, if he writes in rhymed form. For rhymes are the bells of English verse, and there are rhymes of every sound and every metal. You can set a whole peal ringing at once, as Poe did in 'The Bells' or as Southey did in 'The Cataract of Lodore':

> Advancing and prancing and glancing and dancing . . .
> And dashing and flashing and splashing and clashing.

You can ring them against each other, single rhymes against double rhymes:

> So, we'll go no more a roving,
> So late into the night,
> Though the heart be still as loving
> And the moon be still as bright.

You can play tricks with them, as W. S. Gilbert did in his patter songs:

> From the greengrocer tree you get grapes and green pea,
> cauliflowers, pineapple and cranberries,
> While the pastry-cook plant, cherry-brandy will grant,
> apple puffs and three corners and banberries.

You can use very simple rhymes, as A. E. Housman does in his perfect

Loveliest of trees, the cherry now
Is hung with bloom along the bough,
And stands about the woodland ride
Wearing white for Eastertide.

Now, of my three score years and ten,
Twenty will not come again,
And take from seventy springs a score,
It only leaves me fifty more.

And since to look at things in bloom
Fifty springs are little room,
About the woodlands I will go
To see the cherry hung with snow.

You can use rather odd ones, as Browning often does:

I the Trinity illustrate
Drinking watered orange-pulp,
With three sips the Arian frustrate
While he drains his at one gulp.

But, whatever your mood, you will generally find a rhyme to suit it. For English is rich in rhymes.

Meter

Meter comes from the Greek *metron* (measure) and is the measured rhythm of a line of verse. The simplest way to define a meter is to call it a series of lines of verse in which each line has the same number of strong beats—places where the voice of the reader stresses a word or a syllable of a word.

"Hickory dickory dock." As you read it, you say "HICKory DICKory DOCK." Your voice makes the stresses automatically. It is like a fist tapping a punching-bag three times. "HICK" and the bag flies away; "DICK" and you strike it as it returns; "DOCK" and the bag flies away for the last time. And when you read the next line, you do the same thing: "The MOUSE ran UP the CLOCK." Three more taps on the punching bag. Then, for variety's sake, the meter changes. "The CLOCK struck ONE, And DOWN he RUN." Only two taps apiece to the line this time. Then a return to the first three-tap meter: "HICKory DICKory DOCK."

The three-tap meter is called *trimeter* (three-foot), the two-tap meter *dimeter* (two-foot). *Tetrameter* is four-foot meter, *pentameter* five-foot, and so on, from a meter as short as the *monometer* (one-foot) to the long *octometer* and *nonometer* (eight- and nine-foot). It is a wide range, a wide and varied keyboard.

The stressed and unstressed syllables in a poetic foot are rather like the dots and dashes in the Morse telegraphic code. In scanning poetry—that is, in analyzing it for its rhythm—they are usually represented by the following signs:

◡=dot=short syllable, unstressed by the voice
—=dash=long syllable, stressed by the voice

The syllables are not really long or short in themselves; it is the stress of the voice that counts. Feet are made up of combinations of stressed and unstressed syllables. Some of these combinations are:

	——spondee	
◡—iambus	◡◡—anapest	◡—◡amphibrach
—◡trochee	—◡◡dactyl	—◡—amphimacer

Perhaps the easiest way to remember them is from this verse of Coleridge's:

Trochee trips from long to short;
From long to long in solemn sort
Slow Spondee stalks; strong foot! yet ill able
Ever to come up with dactyl trisyllable.
Iambics march from short to long—
With a leap and a bound the swift Anapests throng;
One syllable long, with one short at each side,
Amphibrachys hastes with a stately stride;—
First and last being long, middle short, Amphimacer
Strikes his thundering hoofs like a proud high-bred racer.

Suppose we take two lines and scan them.

John Gilpin was a citizen
Of credit and renown.

Read it and see where the strong stresses are.

John GILpin WAS a CIT-i-ZEN
Of CREDit AND reNOWN.

Then divide it into feet and mark the long and short syllables.

John Gil | pin was | a cit | izen
Of cred | it and | renown.

The first line is iambic tetrameter, the second iambic trimeter. But listen to the beat of the anapests in

I gal | loped, Dirck gal | loped, we gal | loped all three.

Here is tetrameter too, but a strongly anapestic tetrameter, making for a much longer line and a differing rhythm.

The great Greek meter was the hexameter (six-foot), the meter of the 'Iliad' and the 'Odyssey'. It has never acclimated itself very well in English, though we have an example in Longfellow's 'Evangeline':

This is the | forest pri | meval, the | murmuring |
pines and the | hemlocks.

The meter holding a similar position in English, the meter of Shakespeare's plays and Milton's 'Paradise Lost' is the iambic pentameter (short-long, five-foot meter). When it is unrhymed we give it a name of its own and call it *blank verse*. Here is Shakespeare.

Once more unto the breach, dear friends, once more
Or close the wall up with our English dead

and again

The singing masons building roofs of gold

and again

Tomorrow and tomorrow and tomorrow
Creeps in this petty pace from day to day
To the last syllable of recorded time;
And all our yesterdays have lighted fools
The way to dusty death. Out, out, brief candle!
Life's but a walking shadow, a poor player
That struts and frets his hour upon the stage
And then is heard no more. . . .

Here is Milton.

Of Man's first disobedience and the fruit
Of that forbidden tree whose mortal taste
Brought Death into the world and all our woe . . .
Sing, Heavenly Muse, . . .

and again

Thick as autumnal leaves that strew the brooks
Of Vallombrosa, . . .

Here is Robert Frost.

> Something there is that doesn't love a wall
> That sends the frozen ground-swell under it
> And spills the upper boulders in the sun.

All very different, all wonderfully varied, yet all using the same basic structure.

Pattern

There are certain set patterns in poetry as there are certain regular meters. For convenience in discussing rhyme schemes we indicate identical rhymes by the same letter. A *couplet* consists of two lines of verse rhyming *aa;* a *quatrain* of four lines, rhyming in various combinations. 'We'll go no more a roving' (quoted before) is a quatrain. The *heroic couplet* is two rhymed lines of verse in iambic pentameter. Alexander Pope, the waspish, superb technician who was one of the most characteristic poets of the reasonable Eighteenth Century, wrote largely in the heroic couplet and made it as trim and telling as the sting of a bee.

> A little learning is a dangerous thing.
> Drink deep, or taste not the Pierian spring.

The *Spenserian stanza* is named after Edmund Spenser, who wrote the 'Faerie Queene'. It is a form, often used to tell a story, in which each separate stanza consists of eight lines of iambic pentameter, rhyming *ababbcbc,* and a line of iambic hexameter at the end, rhyming *c.* This hexameter line is called an *Alexandrine.* The following example of a Spenserian stanza is from Lord Byron.

> Roll on, thou deep and dark blue Ocean—roll!
> Ten thousand fleets sweep over thee in vain;
> Man marks the earth with ruin—his control
> Stops with the shore;—upon the watery plain
> The wrecks are all thy deed, nor doth remain
> A shadow of man's ravage, save his own,
> When for a moment, like a drop of rain,
> He sinks into thy depths with bubbling groan,
> Without a grave, unknell'd, uncoffin'd and unknown!

Perhaps the most famous of the set patterns in English poetry is the *sonnet.* It must consist of fourteen lines of iambic pentameter, rhymed usually in one of two ways. Here is a sonnet on the sonnet itself, by Richard Watson Gilder.

> What is a sonnet? 'Tis the pearly shell
> That murmurs of the far-off murmuring sea;
> A precious jewel, carved most curiously;
> It is a little picture, painted well.
> What is a sonnet? 'Tis the tear that fell
> From a great poet's hidden ecstasy;
> A two-edged sword, a star, a song—ah me!
> Sometimes a heavy-tolling funeral bell.
>
> This was the flame that shook with Dante's breath;
> The solemn organ whereon Milton played
> And the clear glass where Shakespeare's shadow falls;
> A sea this is—beware who ventureth!
> For like a fiord the narrow floor is laid
> Mid-ocean deep sheer to the mountain-walls.

This sort of sonnet, rhyming *abbaabba cdecde,* we call a Petrarchan or Italian sonnet, from Petrarch, the great Italian poet. The other customary form of the sonnet, consisting of three quatrains with an ending couplet *(abab cdcd efef gg),* we call a Shakespearean sonnet. Here is one of the great Shakespearean sonnets. Notice the difference in rhyme scheme.

> Shall I compare thee to a Summer's day?
> Thou art more lovely and more temperate:
> Rough winds do shake the darling buds of May
> And Summer's lease hath all too short a date.
>
> Sometime too hot the eye of Heaven shines
> And often is his gold complexion dimm'd;
> And every fair from fair sometime declines,
> By chance, or nature's changing course, untrimm'd.
>
> But thy eternal Summer shall not fade
> Nor lose possession of that fair thou ow'st;
> Nor shall Death brag thou wander'st in his shade,
> When in eternal lines to time thou grow'st;
>
> So long as men can breathe, or eyes can see,
> So long lives this, and this gives life to thee.

The first eight lines of any sonnet are called the octave, the last six the sestet. The sonnet is a strict form; a poem with thirteen lines or fifteen lines, though it may be a very beautiful poem, is not a sonnet. Gilder's own sonnet suggests some of the difficulties facing the poet who wishes to bring his sonnet to perfection.

Certain other forms, chiefly those borrowed from the French (the *ballade, villanelle, rondeau,* and so on), are also very strict patterns. That is the fun of working in them—the fun of working within certain known limits. Outside of these forms, the poet makes his own pattern. He may write a poem as long as 'Paradise Lost' entirely in one meter, blank verse. He may write as Shelley did in 'To A Skylark':

> Hail to thee, blithe spirit!
> Bird thou never wert,
> That from heaven, or near it,
> Pourest thy full heart
> In profuse strains of unpremeditated art.

Here the pattern in each stanza makes use of more than one meter, more than one sort of rhyme, and plays long lines against shorter ones. But once the form is established, that form is followed throughout the poem. The poet may write, as Matthew Arnold does in the beginning of 'Philomela',

> Hark! ah, the nightingale!
> The tawny-throated!
> Hark! from that moonlit cedar what a burst!
> What triumph! hark, what pain!

Here the meter is irregular, the verse unrhymed; it is the rhythmic pattern of the poem which makes the music. In fact, once the poet knows his business, he may do as he pleases, except in the strict forms. He may write in free verse, blank verse, rhymed verse, regular meters, irregular meters. But he must stir your imagination and do it in a way that is not the way of prose. If he writes

> At 10:35
> Mr. John W. Higgins
> Went down town to the grocery
> To get a loaf of bread,

he is not writing poetry but chopping up a piece of prose and arranging it in lines. If he writes, as Whitman did,

As toilsome I wandered Virginia's woods,
To the music of rustling leaves kicked up by my feet (for 'twas autumn)
I marked at the foot of a tree the grave of a soldier;
Mortally wounded he and buried on the retreat (easily all I could understand)
The halt of a mid-day hour when up! no time to lose—yet this sign left
On a tablet scrawled and nailed on the tree by the grave
Bold, cautious, true and my loving comrade.

Long, long I muse then on my way go wandering,
Many a changeful season to follow and many a scene of life
Yet at times through changeful season and scene, abrupt, alone or in the crowded street,
Comes before me the unknown soldier's grave, comes the inscription rude in Virginia's woods,
Bold, cautious, true and my loving comrade.—

he is writing poetry, though pattern and meter are irregular and there is no rhyme. But there is a music in the pattern, and the poem says more than its words. It is not told in the way of prose.

The Various Kinds of Poetry

There are kinds of poetry as there are kinds of meters. A *lyric* is a brief, intense burst of music in words—"Where the bee sucks, there suck I"; "With rue my heart is laden"; "Come unto these yellow sands." It must mount into the air or it is nothing. A poem 250 lines long, though it might have lyric qualities, would not be a lyric. Lyric poetry is singing poetry.

Elegiac poetry grieves for a dead friend. Gray's 'Elegy in a Country Churchyard', Milton's 'Lycidas', and Tennyson's 'In Memoriam' are elegies. An *ode* usually deals with an exalted or impersonal subject in a somewhat formal pattern—Keats' 'Ode to a Grecian Urn' and Lowell's 'Commemoration Ode', though quite different, are good examples of the form.

Narrative poetry tells a story. *Epic* poetry is, or should be, poetry dealing with heroic subjects in a heroic manner. A *ballad* is direct and simple, a swinging tune about war or love or stirring events— 'The Bonny Earl of Murray' is a ballad. 'Casey Jones' is a folk-ballad of our own; so are such cowboy songs as 'The Old Chisholm Trail'.

Dramatic poetry builds a drama or play. Shakespeare's plays are the best examples of dramatic poetry in English. *Didactic* poetry is intended to teach a lesson or to point a moral. Pope's 'Essay on Criticism' is of this type.

How to Learn to Appreciate Poetry

The poems we first hear in childhood—the nursery rhymes, the verses in first readers—are usually rhymed poems with a strong, simple beat. Later on we come to poetry that is unrhymed and sometimes, in modern poetry, to poetry that seems at first glance to lack both rhyme and pattern. How can we appreciate this? We must train our ear for it, as we train our ear in music to appreciate counterpoint and harmony. We can do so best by remembering first of all that poetry is meant to be heard as well as read. If a passage or a poem seems unmelodious to you at first, read it over to yourself, aloud or half-aloud, feeling for the music and the pattern that were in the poet's mind. If in classic poetry you encounter such creatures as Arimaspians, such allusions as "Thee bright-haired Vesta long of yore To solitary Saturn bore," such words and contractions of words as *eftsoons*, *prithee*, *'twas*, and *erst*,—find out what they mean, of course, but get the rhythm of the music first. You need not know, for instance, in the lines of Milton's quoted previously, the exact geography of Vallombrosa; the rustling word itself tells you that it is a place where leaves fall thickly in the autumn. You need not know, at first glance, all the technical merits and defects of a poem, any more than you have to know about all the nails in a chair to like the chair. It is a good thing to stretch your mind against the close-packed thought of certain great passages of poetry, but first of all let the words sing to you. If, in modern poetry, certain words and phrases seem to you "unpoetic," remember that poetry is made from live words, current words, not dead ones. It must have the salt and sting of life in it, or it is not great. And remember also that as a modern poet, Archibald MacLeish, has said,

> It is true also that we here are Americans:
> That we use the machines: that a sight of the god is unusual . . .
> The things of the poet are done to a man alone.

Each age makes its own poetry. It cannot copy the poetry of a past age and produce living work. And poetry is not all in books; some of it is being made today. Only, it must be heard.

The Magic and Mystery of Poetry

For that is the first thing poetry asks—to be heard. After that there are other things. There is the curiously magical effect of certain words, certain sounds, certain images brought together. "Come unto these yellow sands And then take hands." "Old unhappy far-off things And battles long ago." "O, we were sisters, sisters seven! We were the fairest under heaven!" There are lines that stir the mind like a bugle, and lines that fade away into forest-distances, "Annihilating all that's made To a green thought in a green shade." There are lines that seem to hold great wisdom and great peace: "I saw Eternity the other night Like a great ring of pure and endless light All calm as it was bright." But they must be heard before they become part of our minds.

The poet William Blake once wrote: "'What?' it will be questioned, 'When the Sun rises, do you not see a round disk of fire somewhat like a guinea?' O no, no, I see an innumerable company of the heavenly Host, crying 'Holy, Holy, Holy is the Lord God Almighty!' I question not my corporal or vegetative eye any more than I would question a window, concerning a sight. I look through it and not with it."

The difference between those two ways of looking at the sun is the difference between the prose way of looking at life and the poetic way. Not because poetry asks us to live in an unreal world; that is not its purpose. But it can make the world we live in different and more shining.

POINCARÉ (*pwăṅ-kȧ-rā'*), RAYMOND (1860-1934). Of all the statesmen who shaped the policies of France during the early years of the 20th century, none was more deeply convinced that war with Germany was inevitable and none had done more to prepare France for the conflict than Raymond Poincaré.

After serving as minister of public instruction and minister of finance, he became premier. This was in 1912, when relations with Germany were strained over Morocco. Poincaré himself took the post of minister of foreign affairs. He followed an anti-German policy and cemented the friendship of France with Great Britain and Russia. Two years later he was elected president, continuing in this office throughout World War I. In the Peace Conference he fought for the infliction of harsh terms on Germany.

At the end of his term of office, in 1920, Poincaré was re-elected to the senate, and three times more he was called on to serve as premier. It was with Poincaré as premier that France marched troops into the Ruhr in 1923 to force reparations payments by Germany. In 1926–28 he stabilized the franc and saved the nation from financial disaster.

POISONOUS PLANTS. Many plants produce poisonous substances in the processes of growth. They may cause sickness and even death if they are eaten by humans or livestock. Some cause severe skin inflammations. Poison ivy, poison oak, and poison sumac are the most familiar of the plants that poison by skin contact. Animals seldom are affected by such plants, probably because they are protected by a covering of fur or hair.

Children are made ill by eating some attractive, colorful berries. The purple berries of pokeweed (*Phytolacca americana*) and the red berries of European bittersweet, or nightshade (*Solanum dulcamara*), are common offenders. Older people sometimes mistake berries, seeds, and roots for those of a familiar edible plant. The poison hemlock which killed the Greek philosopher Socrates was probably brewed from a plant (*Conium maculatum*) of the parsley family. It grows in waste places in the eastern United States and on the Pacific coast. Cases of poisoning arise from mistaking the seeds for anise, the leaves for parsley, or the roots for parsnips. Livestock are killed by eating the fresh green leaves in the spring.

Special Conditions of Poisoning

The poison may be present only in certain parts of the plant, such as the rootstocks or the seeds. Or it may be present only under certain conditions and at certain times of the year. Cocklebur, for example, is poisonous as a seedling, but later in its development it is harmless. A favorite fruit in southern Florida and the islands of the Caribbean is the akee (*Blighia sapida*). But the fruit, both underripe and overripe, is poisonous and can cause death. It should not be eaten until the seed capsule has opened, and it should not be eaten if the fruit is overripe and soft.

Some plants are able to absorb selenium compounds from certain kinds of soil in sufficient quantity to make them poisonous. "Alkali disease" and "blind staggers" in cattle and horses have been traced to *seleniferous* plants. Among them are wild aster and various milk vetches, or locoweeds.

A number of plants produce deadly prussic acid They are known as *cyanogenetic*. The wilted leaves and blossoms of wild black-cherry trees may contain prussic acid until they have dried. The cherry stone also contains the poison. Wild chokecherry and pin cherry, flax, Christmasberry, sorghum, Johnson grass, and Sudan grass are in this group.

Animals that have consumed a large amount of buckwheat will develop symptoms of poisoning if they are exposed to strong sunlight. St.-John's-wort, alsike clover, and bur clover are other plants causing *photosensitization*, or light sensitivity.

Many plants produce herbage which may be eaten either green or dried in hay. But the seeds may be highly poisonous. Among these are flax, corn cockle, field peppergrass, and various kinds of mustard.

The foliage or seeds of some of our loveliest and commonest garden and wild flowers, such as larkspur, clematis, lupine, black hellebore, or Christmas rose, and many of the lilies, contain poisons. They are not dangerous because they are seldom or never eaten Powerful drugs used in medicine are extracted from poisonous plants—digitalis (foxglove), aconite (monkshood), nicotine (wild tobacco), opium (poppy), and atropine (belladonna). (*See also* Narcotics.)

Plants Poisonous to Livestock

Well-fed browsing and grazing animals seem to avoid poisonous plants. Cattle must be half-starved before they will eat white snakeroot or water hemlock, and

LEAVES AND BERRIES OF POISON IVY

"Leaves three, let it be; berries white, hide from sight." This old saying helps one to remember the villainous poison ivy. Notice the longer stalk of the middle leaf.

SOME ABUNDANT POISONOUS PLANTS

White snakeroot (left) is poisonous to livestock. The poison may be transmitted to humans through the milk of cows, causing "milk sickness." Children are sometimes tempted to eat the bright red berries of European bittersweet, or nightshade (center). Water hemlock (right) is eaten by livestock when there is a shortage of forage. Leaves, fruit, and roots are poisonous.

even goats avoid Jimson weed, May apple leaves, and other dangerous plants. Most cases of stock poisoning occur in the early spring when grass is still short or in late summer when it has dried up. When too many animals graze on a range the native forage plants are destroyed and poisonous weeds invade the land. Thus stock poisoning is always more frequent on overgrazed land (*see* Cattle).

A common plant of the same family as the poison hemlock already mentioned is water hemlock, also called spotted cowbane (genus *Cicuta*). Various kinds are found in wet meadows and along ditches and streams throughout the United States and southern Canada. It is no relation to the evergreen tree. The flowers resemble Queen Anne's lace, to which the plant is related. The rootstocks are the most poisonous part but the leaves and fruits are also dangerous. Cattle are usually poisoned in spring when the leaves are fresh and other forage is not yet available.

A species of laurel with narrow leaves and small flowers, called lambkill, or sheep laurel (*Kalmia angustifolia*), is poisonous enough to kill sheep. It is native to eastern North America on dry hillsides, sandy soils, and in bogs.

White snakeroot (*Eupatorium urticaefolium*) is widespread in woodlands and damp fields and pastures of eastern North America west to Manitoba and Texas. The milk of cows that have eaten its flowers and leaves causes "milk sickness" in humans.

On the western sheep lands a deadly weed, halogeton (*Halogeton glomeratus*), first observed in 1935, has infested hundreds of thousands of acres. It was probably imported with some grass seed from Russia. It is a red-stemmed bush with tiny yellow blossoms, resembling Russian thistle in its early stages of growth. It contains fatal oxalic acid. No practical way to wipe out the weeds with chemicals has been found. It thrives on semidesert areas where other vegetation is sparse. Overgrazing and grass fires give it a clear path. The cure seems to lie in planting grasses which will crowd it out and in carefully regulating the number of sheep grazing in a given area.

Many plants that are not poisonous give a disagreeable flavor to milk and even to the meat of cattle. Wild garlic and onion, oxeye daisy, wormwood, camomile, or dog fennel, and chicory are among these troublesome weeds. Different kinds of spurges not only affect the quality of milk but reduce its quantity.

Poison Ivy and Other Skin Irritants

The milky sap of a spurge, snow-on-the-mountain (*Euphorbia marginata*), causes a severe skin inflammation in some people. The hairy leaves and stems of the different lady's-slippers (genus *Cypripedium*), wild parsnip (*Pastinaca sativa*), and primrose (*Primula obconica*) are also responsible for skin irritations.

The most familiar of all the plants causing skin irritations is poison ivy (*Toxicodendron radicans*). It grows abundantly throughout the eastern United States and southern Canada. It climbs up trees and among bushes along roadsides. It luxuriates in fence corners, in neglected pastures, and even in wastes of sand where little other vegetation can exist. Sometimes it assumes an upright shrubby growth. Usually it is a trailing vine, clinging to its support by a thick fringe of aerial rootlets that appear along the stem. (For picture in color, *see* Flowers.)

It has three leaflets. In the spring when they first appear and in the fall they are scarlet. In summer they are a shining green. Poison ivy is often confused with the harmless Virginia creeper, or woodbine. The latter has *five* leaflets instead of three. The berries of poison ivy are waxy white. Those of woodbine are dark blue. It may be distinguished from some other plants with three leaflets by the fact

that the stalk (petiole) of the center leaflet is longer than the other two. (*See also* Ivy; Virginia Creeper.)

The active irritant in poison ivy is an oil called *urushiol*. It is found in the leaves, flowers, fruits, and bark of stems and roots. Cases of poisoning can develop at all seasons of the year from handling the broken stems, the leaves, or the berries which persist all winter. Even standing in the smoke of burning ivy will cause poisoning. The toxin may be transmitted by the fur of pets who have brushed through the plants, by garden tools, firewood, in fact by anything to which the oil can cling.

Not everyone is subject to ivy poisoning, and some people who are immune for years may suddenly become highly sensitive to it. From 12 hours to several days after exposure small white skin blisters appear which itch furiously. As the blisters break, the area becomes moist, swollen, and inflamed. Scratching spreads the poison to other parts of the body. Healing may require one to three weeks.

THE POISON SUMAC

Few people can touch the leaves or berries of this beautiful shrub without being poisoned.

Hikers and workers in infested regions should wear boots, heavy socks, long sleeves, and cotton gloves and cover the face and neck with a lather of strong laundry soap. If contact with the plant is suspected the skin should be scrubbed with laundry soap and sponged with rubbing alcohol. This should be repeated three or four times, for inadequate washing only spreads the poison. Soaps with an oil base should be avoided, because the poison is soluble in oil and is spread instead of removed by such soaps. Clothing should be cleaned thoroughly. One may be reinfected by wearing the same clothes and shoes months later.

When poisoning is first detected the area may be bathed with a 5 per cent solution of potassium permanganate or with a solution of 5 parts of iron chloride in 95 parts of a half-and-half mixture of water and glycerin. Calamine lotions will relieve the itching. In cases of severe poisoning a doctor should be consulted.

Closely resembling poison ivy are two species of poison oak. One is found along the Atlantic and Gulf coasts from New Jersey to Texas (*Toxicodendron quercifolium*); the other is on the Pacific West coast (*Toxicodendron diversilobum*). In swamps and in thickets on the borders of ponds or streams, where the waters are acid, clear, or coffee colored, is poison sumac (*Toxicodendron vernix*). All these plants, as well as the mango tree, Japanese lacquer tree, and cashew tree belong to the same family (the cashew family, *Anacardiaceae*), and all contain the poisonous *urushiol*. (*See also* Weeds.)

POISONS. Popular accounts of certain periods of history are crowded with romantic and sensational stories in which poisons play a leading part. The Renaissance period in Europe, particularly in Italy, is pictured as a time when tyrants and unscrupulous statesmen spent much time in administering subtle death-dealing drugs to dangerous rivals and to persons who were an inconvenience to them. They had poisons, we are told, which they had only to rub on paper, cloth, or metal to make these fatal to any who touched them, and they compounded delicate perfumes which brought lingering death to those who breathed their aroma. Next to the Italians, the mysterious men of India are ranked as leading inventors of deadly compounds. Fiction stories and sometimes newspaper reports relate tales of "strange Eastern drugs" which baffle modern science.

These and most statements of a similar character may be dismissed as pure imagination. It is not to be supposed that either the Italians of the Renaissance period or the Hindus carried their knowledge of chemistry beyond what we know today.

The Four Classes of Poisons

There is little mystery about poisons today. Although the action of many complex poisonous substances, such as snake venom or bacteria toxins, may not be fully understood, their general nature and ordinary effects are known. The common poisons are usually classified according to the way they act upon the human body: (1) corrosive poisons, (2) irritant poisons, (3) nerve poisons, and (4) asphyxiants. Substances which are used to counteract the effects of poisons are called "antidotes."

The corrosive poisons are those which "burn" the skin or lining of the stomach. Among the commonest and the most dangerous chemicals of this class is corrosive sublimate, often called bichloride of mercury, which is widely used as an antiseptic. It is prepared usually in the form of a small white tablet and is easily mistaken for a harmless pill. For this reason it is unsafe to leave such tablets where other medicines or drugs are kept. The antidote is the white of eggs beaten up with water. Other common corrosives are sulfuric, nitric, hydrochloric, and oxalic acids, all of which act rapidly and powerfully if strong solutions are swallowed. The antidote for these is powdered chalk or even plaster from the wall. Carbolic acid is another corrosive poison which claims many victims. (For the antidote for carbolic acid, *see* First Aid.)

The irritant poisons are those which set up inflammation in the body and interfere so seriously with its functions as to cause severe sickness or eventual death. They are usually slower and more uncertain in their action than other poisons and for this reason harder to detect and to avoid. To this class belong most of the so-called cumulative poisons, those which can be absorbed little by little into the system without apparent harm, until suddenly they strike down their unsuspecting victims.

Arsenic and all its compounds are the most important of the irritant poisons. A tablespoonful of dialyzed iron at half-hour intervals is the antidote. Many lead, copper and zinc compounds also fall in this group. Aloes and croton oil are good examples of the vegetable irritants. Phosphorus, which is sometimes used for match tips, is among the dangerous chemicals of this class (*see* Matches). Ordinary gum arabic mucilage is a good phosphorus antidote.

Among the most deadly poisons, however, are those which act directly upon the nerves. Of these, prussic or hydrocyanic acid is perhaps the best known. The fumes of this acid are sometimes used to rid dwellings of germs or vermin (*see* Antiseptics). But only professional experts should ever attempt this, for one or two breaths of the fumes will kill almost instantly. Many cyanide compounds, especially cyanide of potassium, are extensively used in the arts. Most of these are just as poisonous as hydrocyanic acid.

Aconitin is an exceedingly deadly poison, which kills in very minute doses. It is derived from certain plants of the aconite family, some of which, such as the monk's-hood or wolf's-bane, are cultivated for their beauty; most of them are poisonous. Antidotes for this as well as for prussic acid are of little use, as the victim is usually dead before they can be applied.

Narcotic drugs act on the nerves and except in very small doses are deadly poisons (*see* Narcotics). Included among them are cocaine, heroin, and the drugs derived from opium (laudanum, codeine, and morphine). The best treatment for these poisons is to keep the patient awake by shaking or even beating him and making him inhale ammonia fumes until a physician can be summoned.

Belladonna and its alkaloid atropine, which is used by oculists to enlarge the pupils of the eyes for examination, is a nerve poison. This drug and morphine are antidotes for each other. Belladonna is obtained from a plant called the deadly nightshade, which has bright scarlet berries often attractive to children.

IT YIELDS A DEADLY DRUG

This is a twig of the tree called strychnos nux vomica, which is a native of Asia. From its seeds strychnine is manufactured. This drug is used in very small quantities as a heart stimulant, but in larger doses is one of the deadliest of poisons.

Strychnine deserves especial warning mention in this group of poisons, because it is so frequently used to get rid of rats, and in the West to kill wolves, coyotes, prairie dogs, and other animal pests (*see* Strychnine). Its effects are very rapid, resulting in convulsions and death within half an hour. Sodium bromide is sometimes used as an antidote. The best method is to keep the patient under the influence of chloroform until the poison has been eliminated. (*See also* Poisonous Plants.)

Gas poisons may be corrosives (like some of the war gases), irritants (like chlorine, bromine, and sulphur dioxide), or nerve poisons (like the anesthetic gases). But the most dangerous of them in the ordinary way of life are the asphyxiants—those which act on the blood through the lungs and prevent it from carrying life-giving oxygen to the body (*see* Blood; Respiration).

Ordinary stove gas is the commonest of the asphyxiant poisons. Chiefly responsible for its effects is the carbon monoxide contained in it. The treatment is artificial respiration given in the fresh air. Carbon dioxide is not a true poison. When it accumulates in a closed space people smother for lack of oxygen and not because of any injury caused by this gas (*see* Carbon Dioxide and Monoxide). The fumes of many liquids, like the carbon tetrachloride used as a cleaner, are classed as poisons. (*See also* Chemical Warfare.)

The Deadliest of All Poisons

Snake venoms are powerful poisons when injected directly into the flesh (*see* Snakes). Other deadly poisons are the toxins generated by bacteria (*see* Antitoxins). The deadliest is the toxin of spore-forming *Clostridium botulinum.* This may develop in food that has been canned without being heated to a temperature high enough to destroy the spores. It has been computed that three ten-millionths of an ounce of botulinum toxin is fatal to an adult of average weight. Food poisoning in general used to be called "ptomaine poisoning" in the belief that it was due to the chemical ptomaines. It is known now that true food poisoning is due to botulinum toxin.

In dealing with poisoning from whatever cause, the first rule is to call a physician. While waiting for help, it is well to make the patient vomit by giving an emetic of powdered ipecac or mustard water, or even soap suds, except when the poison taken is lye, caustic potash, washing soda, or any of the corrosive acids (*see* First Aid). The best way to avoid accidents is to keep no poisons in the household.

The TRAGIC STORY *of* POLAND

Plainly dressed herself, this smiling mother proudly shows off her son in his fancy cap and embroidered pinafore. Polish women usually go barefoot on the farm.

POLAND. For more than a century Poland disappeared from the map of Europe. Resurrected after the first World War, she enjoyed only twenty years of freedom before her traditional enemies, Russia and Germany, again tore her apart. She emerged from the second World War with her lands devastated, her boundaries shrunk, and her population decimated by battle, mass executions, and poverty. Her government was dominated by triumphant Russia. But among her people there remained many to carry on the centuries-old struggle for freedom and complete independence.

The Land and People

The Polish people live in the middle of the north European plain. To the east, their country fades imperceptibly into the steppes of Russia; to the west, into the plains of Germany. From the crests of the Carpathian Mountains on the southern border the land slopes down to a low plateau, breaks up into hills, and then flattens out to a monotonous level. In the north it rises again to ridges along the Baltic coast, turning the rivers in an east-west direction before they find their outlets to the sea.

Through the center of this land the Vistula River describes an S-curve, gathering in the Bug and other tributaries. Marshes, lakes, and forests dot the northern uplands. Winters are cold everywhere with heavy snows; summers are warm, and rainfall moderate (about 24 inches a year).

The Poles belong to the western branch of Slavic people (*see* Slavs). Since the 6th century they have made their home in the broad basin of the Vistula River. (The word Pole in all Slav languages means "field" or "plain.") They are short in stature and as blond as the Scandinavians. Only in the foothills of the Carpathians are brown eyes common.

In early times a warrior class of nobles gained possession of the land and held the peasants in the grip of serfdom. Down into the 20th century they continued in control of their vast estates. The peasants lived in wretched poverty in their small farm villages. But they ornamented their one-room log cabins with woodcarving inside and out. They decorated their homemade furniture, pottery, and wooden utensils with bright colors. And on festal occasions they enlivened their plain peasant dress with gay ribbons, velvet, and embroidery.

The Poles Cling to Their Farms

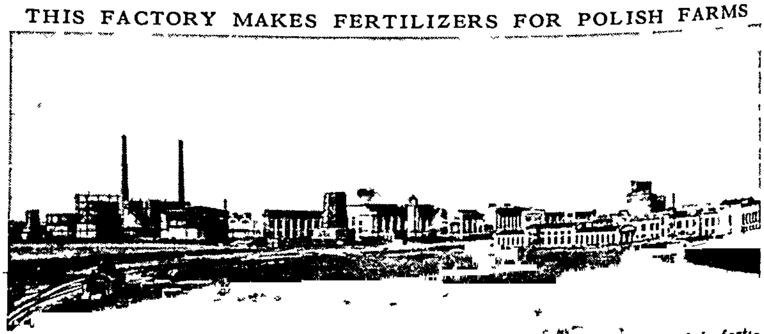
The Polish plains early became crisscrossed with trade routes. Cities grew up at their junction points—Lwow in the east, on the great highway from the Baltic to the Black Sea; Cracow at the head of navigation on the Vistula; and Warsaw farther down the river, where continental routes from the south, east, and west came together (*see* Cracow; Warsaw). In the Middle Ages, German merchants and Jews from western Europe flocked into Polish towns to build up a flourishing commerce; but most of the Poles remained peasant farmers.

On the cold wet lands of the north they raised flax and pastured their horses and cattle as they had done in the Middle Ages. On the great sandy plains of the interior they produced their staple foods—rye and potatoes. Only in the south, on the warm fertile plateaus and in the river valleys, were they able to grow wheat and sugar beets. With their primitive methods and poor soil they produced little surplus grain. They derived their chief income from the sale of poultry and eggs, milk and butter, and bacon and ham from the hogs that were found on every farm.

An Outpost of Western Europe

While the peasants remained poor, the country as a whole managed to develop a rich culture. From the beginning the Poles looked to the West for their inspiration. When they adopted Christianity in the 10th century they chose to follow the Church of Rome rather than the Orthodox Eastern Church. Monks taught them to write their language in the Latin alphabet. Their first great university, founded at Cracow in 1364, looked to Italy and France for its learning. Poland therefore came to regard herself as an outpost of the Western world, defending the precious values of Western culture against the ideas and institutions of the East.

THIS FACTORY MAKES FERTILIZERS FOR POLISH FARMS



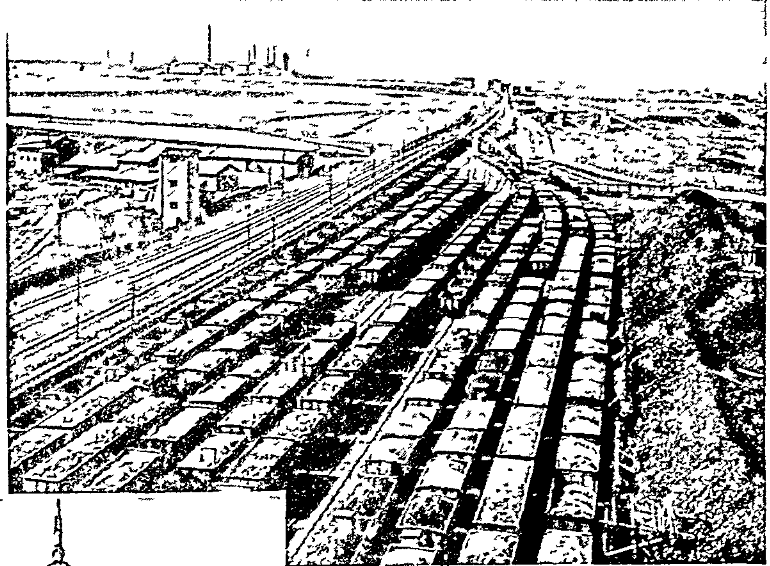
This large chemical factory near Tarnow, in southern Poland, produces mainly fertilizers—sorely needed on Poland's poor soils. Though mainly an agricultural country, Poland made a striking advance in industry under the Republic.

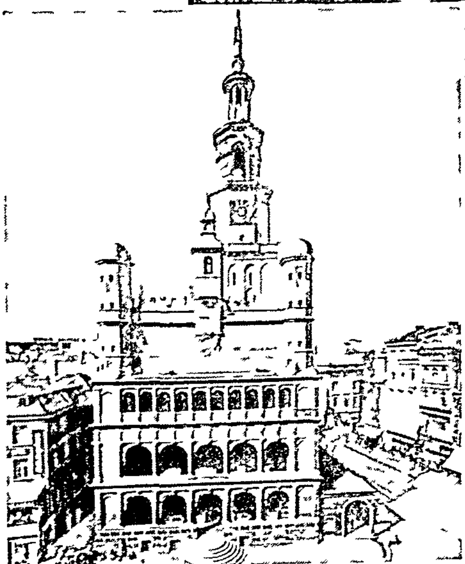
Night fell on Poland in the 19th century and again in the 20th when she was blotted out from the map of Europe. Her foreign rulers tried to stamp out Polish

patriotism and culture. But the people of the captive state clung tenaciously to their traditions and kept alive their faith in a free Poland. Zealous in their religion, they continued their devotions in the great cathedrals and wooden churches that covered the land.

Whether free or under alien rule, Poland has contributed to the world many great men and women. To science she gave Copernicus, the astronomer, and Marie Curie, the discoverer of radium. To the cause of freedom she lent John Sobieski, who battled against the Turks at Vienna in 1683, and Kosciusko and Pulaski, who enlisted in the American struggle for independence. To music she added the names of the composer Chopin, the pianist Paderewski, the singer Sembrich and to the stage, Modjeska. To literature she contributed one of the greatest of Slav lyric poets Mickiewicz; the novelist Sienkiewicz; and Korzeniowski, who, under the pen name of Joseph Conrad, became one of the master storytellers in the English language.

MODERN INDUSTRY AND MEDIEVAL ARCHITECTURE





Trainloads of high-grade coal (above) leave the rich mines of Upper Silesia on Poland's southwest border. Below we see the magnificent City Hall at Poznan. Built in the 13th century, it follows in the main the pattern of Polish medieval architecture. Poznan, 170 miles west of Warsaw was the residence of Poland's first king.

Industrial Development Held Back

During Poland's long years of bondage her people were practically excluded from the industrial progress of the Western nations. They cut timber from the great forests of the north and on the slopes of the Carpathians. They worked the salt, lead, and zinc mines on the southern plateau for their foreign rulers. But only in the textile mills of Lodz, southwest of Warsaw, could the surplus farm population find an outlet in industry. Jews and Poles crowded into this great slum city, which long supplied most of Russia with cotton and woolen goods.

After the first World War, when Poland gained the rich coal fields of Upper Silesia on her southwest border, she began to develop heavy industry and a variety of manufactures. The boundary changes after the second World War shifted the center of the country still farther to the west over industrial areas of Germany. What Poland's future will be we can only guess after reading of her tragic past down through the ages.

The Violent, Checkered History of Poland

Poland emerges from the mists of legends into recorded history in the 10th century. In the 11th century she achieved a brief period of unity. Then for 200 years her nobles plunged her into civil war, while Tatars from the East repeatedly devastated her lands. In the 12th century she lost her free access to the Baltic Sea when she allowed Teutonic Knights from Germany to move in and establish themselves in Prussian lands on the lower Vistula River (*see* Prussia).

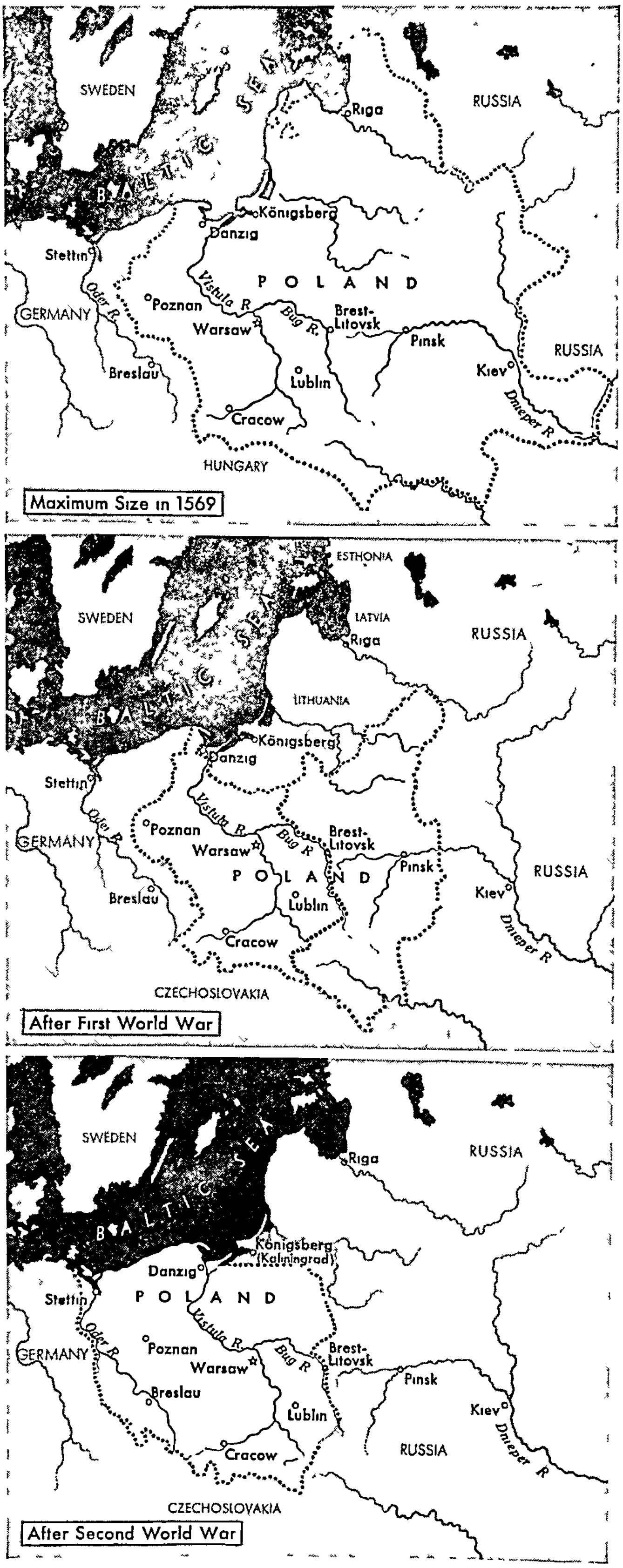
Finally strong kings appeared who were able to curb the power of the nobles. The Poles achieved political and cultural unity under their greatest ruler, Casimir the Great, who ruled from his capital at Cracow from 1333 to 1370. In 1386 Poland was united with Lithuania to the east by the marriage of her young queen, Jadwiga to the Grand Duke of Lithuania, Jagiello. In the next century the Poles wrested Danzig, at the mouth of the Vistula, from the Teutonic Knights and kept it for 300 years (*see* Danzig). The joint Polish-Lithuanian kingdom stretched from the Baltic to the Black Sea and was the largest country in Europe after Russia. In the 16th century Warsaw, Poland's new capital, was second only to Paris in brilliance (*see* Warsaw).

Poland Suffers Three "Partitions"

In the 18th century Poland's arrogant aristocracy again brought ruin to the country. The constitution required that every measure introduced into the Diet must be adopted unanimously. This meant that a single noble could bring all business to a standstill through his right of veto (*liberum veto*). The nobles used this privilege to avoid payment of taxes. As a result Poland had no treasury, no fixed revenue, no ambassadors at foreign courts. Her king was powerless.

In spite of frontiers difficult to defend, Poland had kept her independence for more than 800 years.

THE SHRINKING BOUNDARIES OF POLAND



A great nation in the 16th century, Poland twice disappeared from the map and was twice reborn, each time smaller in size.

Now her neighbors took advantage of her weakness. In 1772 and 1793 Russia and Prussia joined with Austria in seizing large slices of Polish territory. Thaddeus Kosciusko rallied the Poles about him and swore to fight to the end for liberty. Prussia and Austria, however, quickly crushed his forces, and in 1795 a third partition wiped Poland completely off the map.

A New Birth of Freedom

Before 1914 there seemed little hope that Poland would ever exist again as an independent nation. Then the first World War, which also brought misery and devastation to the country, provided the opportunity for its revival. One of President Wilson's "Fourteen Points" for the settlement of the war was the creation of a free Poland. Marshal Pilsudski, released from a German prison, returned to Warsaw to head the new state. A constitution was adopted in 1921 and a republic set up.

The boundaries fixed by the Treaty of Versailles did not, however, satisfy Polish claims. Access to the Baltic Sea was provided only through the Polish Corridor, a narrow strip along the Vistula River, which cut through German lands. Dissatisfied also with her eastern boundary, Poland in 1920 seized Wilno, the capital of Lithuania, and launched a successful attack on Russia. The Treaty of Riga, signed by Russia in 1921, pushed Poland's boundaries about a hundred miles farther to the east. Poland now had an area of 150,000 square miles and a population of 32,000,000.

The new state faced formidable problems. Her lands had been scourged, her people were ragged and starving. The aristocratic classes clung to their ancient privileges, refusing to divide their great estates. Large minority groups were included within the new borders—Ukrainians and Ruthenians in the east, and Germans in the west, who retained their national characteristics to a great degree. The new government was slow in carrying out its land-reform program; and it failed to satisfy the minority groups.

After a brief period of prosperity inflation set in, and by 1925 Poland faced bankruptcy. Pilsudski, who had refused to run for president in the first elections of 1922, now appeared in Warsaw at the head of his troops, overthrew the government, and set up a dictatorship. In 1934 he signed a nonaggression pact with Hitler.

When Hitler dismembered Czechoslovakia in 1938 he allowed Poland to rush in and seize a part of the spoils. Poland also sought to ally herself with several smaller nations. But in 1939 Germany broke its friendship pact with Poland and demanded Danzig and a strip across the Polish Corridor. Rejecting Russia's

offer of help, Poland accepted a guarantee of support from Great Britain. Hitler delayed until he had concluded a nonaggression pact with Russia. Then on Sept. 1, 1939, he attacked Poland and launched the second World War (*see* World War, Second).

The Polish army was soon crushed; and on September 17 Russia, acting in agreement with Germany, moved into Poland from the east. Polish resistance continued only in Warsaw, which held out heroically until September 27. On September 28 Germany and Russia signed a new "treaty of friendship and frontiers" which divided Poland between them. The boundary followed the Curzon Line, proposed by the Allies in 1919 on ethnic grounds.

In the summer of 1941 Germany attacked Russia, and its eastward sweep brought all Poland under Nazi rule. For five years Poland suffered under the Nazi occupation. The Germans shipped two million Poles to Germany for compulsory labor and executed hundreds of Polish leaders—professors, lawyers, clergymen, and landowners. In notorious murder camps at Maidanek, Birkenau, and Oswiecim they exterminated most of Poland's three million Jews, along with Jews of other occupied countries. Thousands of Poles escaped across the border to fight with their allies on all fronts. At home the Polish Underground kept up a fierce resistance.

Russia Occupies Poland

On Jan. 4, 1944, the Red army's victorious drive against the Germans once more crossed the Polish border. On January 11 the Russian government claimed the Curzon Line as its western boundary. The Polish government in exile, in London, refused. In July the Red army reached the Curzon Line, and Russia set up a Communist-dominated government for Poland in Lublin. On Jan. 17, 1945, the Russians drove the Nazis out of Warsaw and the Lublin government moved in.

At the Crimean Conference in Yalta, February 1945. the Big Three (Russia, United States, and Great Britain) agreed that the eastern boundary of Poland should follow the Curzon Line, and that Poland should be compensated for this loss with German territory. They reasserted an intention "to see created a strong, free, independent and democratic Poland." The Western powers proposed that the government in Warsaw should be reorganized to include a few democratic leaders from the government in exile. When this had been done, they recognized the provisional government (July 5, 1945)

Poland Shifts from East to West

At the Potsdam (or Berlin) Conference, July–August 1945, the Big Three powers agreed that "the final delimitation of the western frontier of Poland should await the peace settlement." Pending this, they decided to place "under the administration of the Polish state" the following German territories; *in the north,* the former free city of Danzig and East Prussia (except for the northern tip, which was placed under the administration of Russia); *in the west,* eastern Pomerania, Upper and Lower Silesia, and part of Brandenburg Province. The Big Three recognized that "the transfer to Germany of German populations . . . will have to be undertaken."

Millions of Germans had already fled into Germany. Within a year the Poles cleared out the rest, and some 3 million Poles (about the population of Norway) moved in. The Polish language replaced the German. Danzig was rechristened Gdansk. The old German port of Stettin on the Oder River became Szczecin. Breslau became Wroclaw.

The area of the new Poland, within its provisional boundaries, is 120,359 square miles, about four-fifths the size of the old Poland. The population had shrunk from 32,000,000 in 1939 to less than 24,000,000 in 1946. War and poverty had taken a frightful toll, particularly among the Jews; and some 5,000,000 Ukrainians and Ruthenians had been absorbed into the Soviet Union.

Poland lost its oil wells and its deposits of potassium salts. It gained immense deposits of high-grade coal, zinc, and lead, and low-grade iron ore in Silesia. It gained also more than a thousand industrial plants. These included textile mills, iron and steel works, chemical factories, paper mills, furniture factories, electric power stations, tanneries, and sugar refineries.

The Government Nationalizes Industries

The Polish government seized without compensation all German farmlands and industries. It divided the farmland into small peasant holdings of about 12½ acres each. For industry, it copied the Russian planning program. A Nationalization Law, adopted Jan. 3, 1946, authorized the government to take over all "basic industries," including everything from mines and rolling mills to flour mills and printing plants.

In 1946 the Poles faced semistarvation. Poland had lost half its horses and a third of its cattle and sheep. The American Red Cross, the American Catholic Welfare, and the United Nations Relief and Rehabilitation Administration (UNRRA) sent in food and clothing. To fight inflation, the Polish government seized about half the farm produce at low prices and paid scanty wages in nationalized industries.

Poland became a soviet socialist republic in all but name. Communication with the West was cut off. Russian officers took command of Polish troops. A secret police spied on the people. The government nationalized industry, regimented labor, and shipped coal and textiles to Russia. It set up many collective farms, despite protests from the peasants. It stripped the Roman Catholic church of power by seizing its lands and imprisoning hundreds of priests. It rewrote textbooks to spread Marxist teaching. At times it purged even the Polish Communist party. Most Poles refused to embrace Communism. In an effort to force more peasants to work on collective farms, the government in 1952 decreed that small farmers in "crowded areas" must move to lands under strict state control. The government admitted Western journalists to Warsaw in 1953. They reported that Poland was a "police state" tottering under inflation. Population (1950 census), 24,976,926.

The ROMANCE *and* TRAGEDY *of* POLAR EXPLORATION

POLAR EXPLORATION. No heroes or adventurers can surpass polar explorers in daring and hardihood. They live in cold severe enough to kill a man quickly if anything goes wrong. Their ships may be crushed by ice floes. Huge cracks may open in the ice and swallow dog sleds or foot parties. Airplanes may get lost or wrecked in terrific blizzards.

But for centuries explorers have faced these dangers and hardships to uncover secrets which lie hidden in the polar regions. The regions are not hard to identify. On a globe, the polar regions are the two "ends of the earth," between the poles and the Arctic and Antarctic Circles. But frigid polar conditions extend beyond these limits in many places; so polar exploration extends into these places.

Why do men face such hazards to study these bleak regions? In earlier days, they sought to fill in the blank places on the world map. Many hoped to find short sailing routes from Europe to China and the Indies. Others wanted to locate good sealing and whaling grounds. Many men strove to be first to reach the poles.

Today, explorers from northern nations are studying polar flying conditions because the shortest air routes between North America, northern Europe, and most of Asia lie across the Arctic Ocean (*see* Arctic Regions). Many modern explorers are scientific men who study polar weather, magnetism, geology, and plant and animal life. Explorers also hope to find deposits of uranium and radium.

How Polar Explorers Use Airplanes

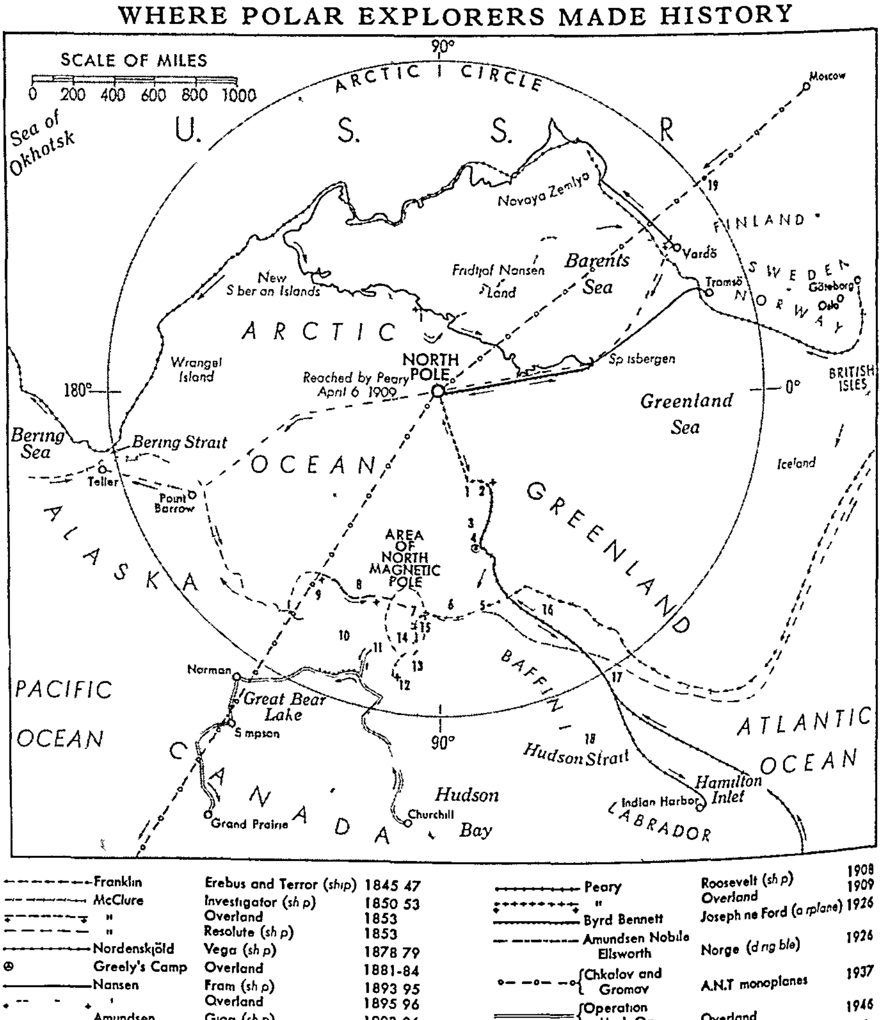
Today, explorers use airplanes equipped with modern fact-finding devices, for quick studies. An airplane can go farther in one day than men could in months or years when they used ships or sledged over ice. Aerial cameras can photograph thousands of square miles of land in a few hours. A plane can send down radarlike pulses; and echoes from the ground tell what kind of rocks lie beneath the ice and snow. Fathometers (sonic depth finders) on the planes can test the depth of glaciers and ice fields. Airplanes can release balloons carrying radio equipment to test weather in the upper air.

But airplane flights cannot be used for getting many kinds of information. Plant or animal life cannot be studied from the air. An air observer cannot make detailed examinations of mineral deposits and he cannot obtain records of weather conditions in stormy times when no airplane can fly. For all such studies men must work on the ground; or, if they use airplanes, from bases on the ground.

Establishing a Polar Base

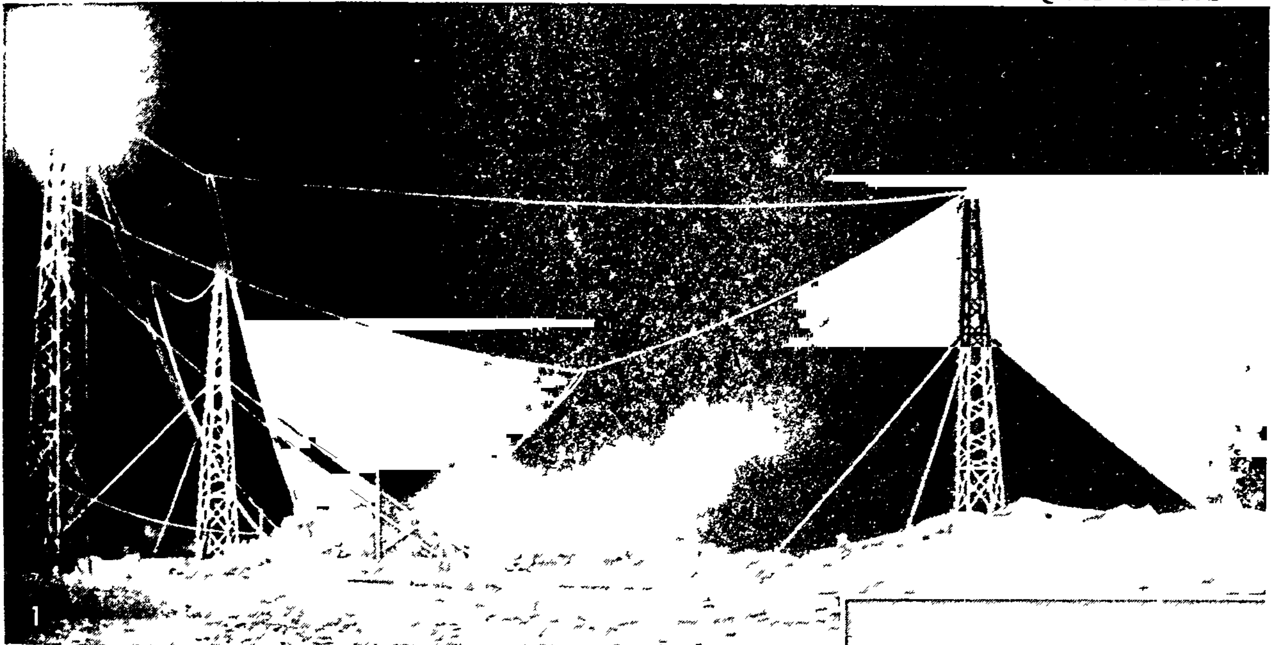
Today explorers do not have much trouble establishing bases in the Arctic regions. Many airfields, weather observation bases, and fur trading posts exist near the Arctic. In summer, locations quite near the

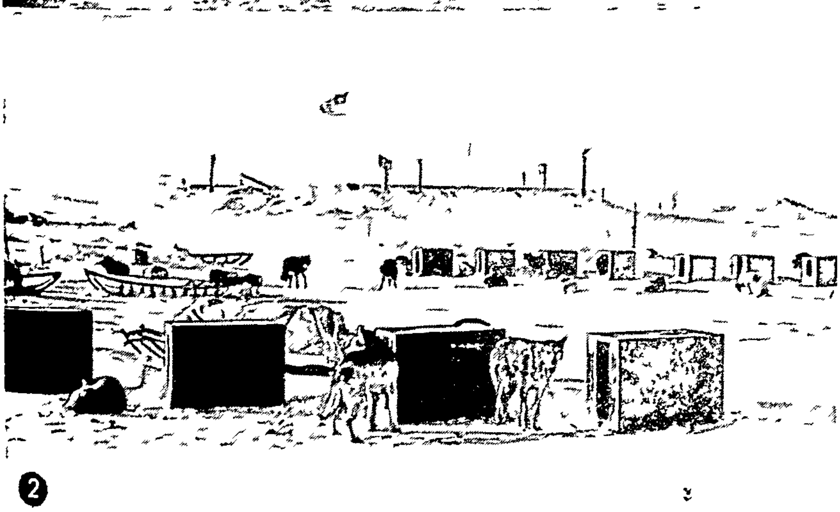
WHERE POLAR EXPLORERS MADE HISTORY

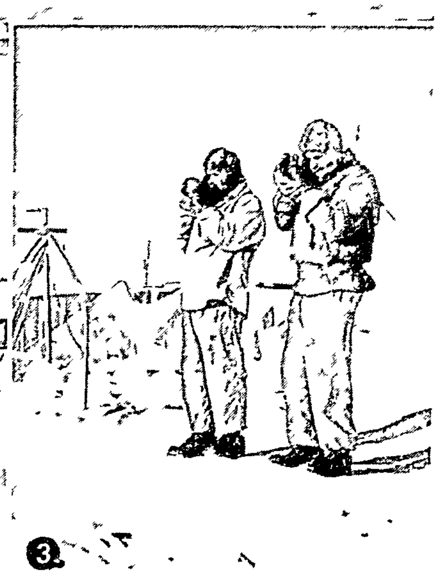


The numbers indicate place names important in Arctic discovery and exploration. 1 Cape Columbia, 2 Cape Sheridan; 3 Ellesmere Island, 4 Cape Sabine; 5. Lancaster Sound; 6 Devon Island; 7. Barrow Strait; 8. Melville Island; 9 Banks Island; 10 Victoria Island; 11. Denmark Bay; 12 King William Island; 13 Boothia Peninsula; 14 Prince of Wales Island; 15 Somerset Island; 16 Baffin Bay; 17. Davis Strait; 18. Frobisher Bay; 19 White Sea.

LIFE AT LITTLE AMERICA, BYRD'S ANTARCTIC HEADQUARTERS







1. Here we see a night view of the ice-shrouded radio station that kept the Byrd expeditions in touch with the United States and with field parties. 2. The main building, marked by an American flag, is almost covered with snow. The sledge dogs stand beside their windproof kennels. Later they had winter quarters under the snow. 3. Two members of the expedition use octants to measure the altitude of the sun at midday, on October 8. We can tell that the Antarctic spring sun rides low in the sky, by noticing the length of the men's noontime shadows.

pole can be reached by ship, and overland travel is possible (*see* Arctic Regions).

Antarctic explorers have a much harder time. The land is surrounded by stormy, ice-choked seas, and ships can reach it only during a few months in summer (*see* Antarctic Continent). So expeditions usually work from one summer through the next.

During the first summer, the ships get through the ice-clogged sea to land men and supplies. The men prepare their headquarters and a landing field if airplanes are to be used. Before March the ships leave, to avoid being frozen in; and the men remain in shelter for the winter. When spring comes in September they commence outdoor work. The ships return in December or January and take the men out.

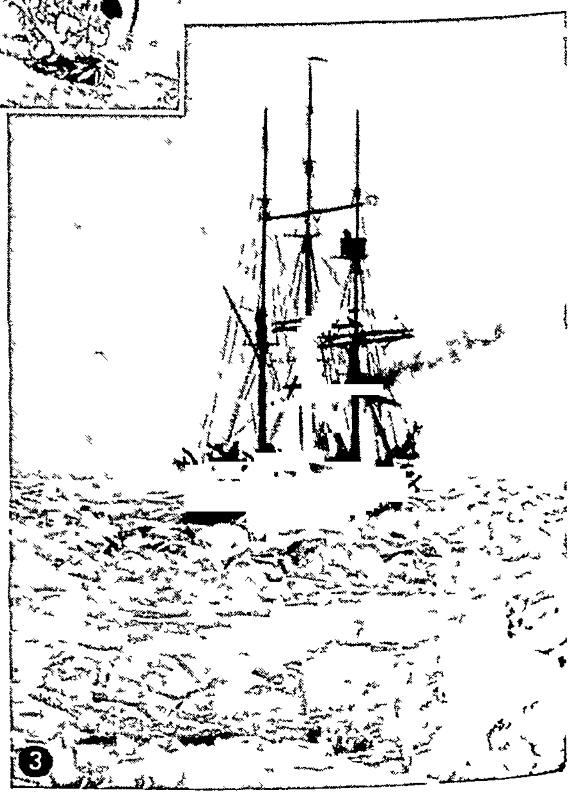
After the second World War, the United States Navy sent an expedition commanded by Rear Adms. Richard E. Byrd and Richard H. Cruzen for one season (1946–47). The expedition made airplane flights, gained experience with its ice-breaking ships, and tested many items of polar equipment. But working time was much too short for intensive field work.

Fighting Polar Cold and Winds

We might think that cold is a polar explorer's worst enemy. But good clothes and food defeat cold. Clothing should have many layers to enclose plenty of air, since air is a fine insulator. Greater hardships and danger are caused by wind. Early explorers soon adopted the Eskimo's costume of furs, since leather and hair make the best windbreak, as well as being warm. But no garment can withstand high winds. Men must find shelter or perish.

Polar explorers wear well-lined boots (mukluks) to prevent frostbite. They wear parkas over the head and

WINTER COMES TO A POLAR REGION



1. Two members of a Byrd expedition are exploring fields of ice around Little America on the Bay of Whales during the long Antarctic night. 2. Two penguins are freeing themselves from snow and ice after a hard storm. 3. This ship (Stefansson expedition, 1913–16) is locked in Arctic ice until the spring thaw frees it.

neck, and face masks to keep off the biting winds The most troublesome item is goggles, or glasses worn to protect the eyes from blinding snow and cutting winds. Body moisture tends to collect on the eyepieces and freeze, blocking vision.

Many problems arise in providing equipment. Metal articles may become brittle and break, if placed under strain in extreme cold. For this reason, polar explorers generally prefer wooden ships, especially if the ship may be locked in ice. Fuel and lubricants for motors must be suitable for use at extremely low temperatures. When airplanes are grounded, the motors are covered with tenting and heat is provided so they can be started readily.

The cold helps, however, by preserving food and keeping down infectious disease. Germs and viruses are kept almost entirely inactive. Food does not spoil, and men do not catch cold, except in heated quarters. When the Byrd expedition of 1946 reached Little America, many foods left in 1941 were found in perfect condition.

The First Polar Explorations

Polar exploration started more than 2,000 years ago. Four centuries before Christ, Pytheas, a Greek from Massilia (Marseilles), found land 600 miles north of Great Britain and called it "Thule." It may have been Iceland, or islands off Norway.

For more than a thousand years, nobody else ventured this far north. In the time of King Alfred of England, Alfred's friend Ottar of Norway sailed around the north end of Norway and discovered the White Sea. In the 9th and 10th centuries the Vikings settled Iceland and the southwestern coast of Greenland (*see* Northmen). But we have no evidence that they ventured far into the frozen seas north of the Arctic Circle.

The first attempts to do this came after the Portuguese and the Spanish discovered sea routes to India. They would not allow other nations to use these routes, so the English, and later the Dutch, tried to find their own routes around the north end of Asia (the Northeast Passage) or of North America (the Northwest Passage). The first explorers toward the east were Willoughby and Chancellor, and the Dutchman, Barents, as shown in the table on the opposite page. The earliest to attempt the Northwest Passage were Frobisher and Davis. After suffering great hardships, they all found that their little sailing ships had no chance to get through the Arctic Ocean ice.

A Lull in Polar Exploration

In 1588, the English defeated the Spanish Armada and opened the Portuguese and Spanish sea routes to all nations (*see* Armada, Spanish). This reduced interest in Arctic exploration. Hudson found a way into Hudson's Bay, and the Hudson's Bay Company used

THE LONG RECORD OF POLAR EXPLORATION

ARCTIC EXPLORATION

Pytheas (Massilia), 4th century B.C., discovered "Thule" (Iceland?) north of Great Britain.

Erik, the Red (Norseman), 10th century, landed on western coast of Greenland; founded a colony.

Hugh Willoughby and Richard Chancellor (England), 1553, explored the White Sea.

Martin Frobisher (England), 1576–78, discovered Frobisher Bay on Baffin Island.

John Davis (England), 1585–87, discovered Davis Strait.

Willem Barents (The Netherlands), 1590–97, discovered Spitsbergen; explored Novaya Zemlya, Barents Sea.

Henry Hudson (England), 1607–11, discovered Hudson Strait, Hudson Bay.

William Baffin (England), 1615, explored Baffin Bay, Baffin Island.

Vitus Bering (Russia), 1728, explored Bering Sea, Bering Strait.

William E. Parry (Great Britain), 1819–20, explored the Northwest Passage from the east to Melville Island.

James C. Ross (Great Britain), 1831, attempted Northwest Passage from both east and west; located north magnetic pole approximately.

Thomas Simpson (Great Britain), 1838–39, explored coast of Canada from Coppermine River to Boothia.

John Franklin (Great Britain), 1845–47, and his entire expedition perished in the Canadian Arctic, seeking the Northwest Passage.

Robert McClure (Great Britain), 1850–53, traversed Northwest Passage; used more than one ship and made part of the journey overland.

Nils Adolf Erik Nordenskjöld (Sweden), 1878–79, traversed the Northeast Passage in the *Vega*.

Adolphus W. Greely (United States), 1881–84, led an ill-fated expedition to Ellesmere Island and the west coast of Greenland.

Robert E. Peary (United States), 1891–92, proved Greenland an island by crossing northeast corner.

Fridtjof Nansen (Norway), 1893–96, drifted in *Fram* to within 250 miles of the North Pole.

Salomon A. Andrée (Sweden), 1897, tried balloon flight over the North Pole; party perished.

Roald Amundsen (Norway), 1903–6, traversed the Northwest Passage in the *Gjöa;* fixed approximate location of north magnetic pole.

Vilhjalmur Stefansson (Canada), 1906–18, explored about 100,000 square miles in Canadian Arctic.

Frederick A. Cook (United States), 1908, said he reached North Pole; his story discredited.

Robert E. Peary (United States), 1909, reached the North Pole.

Donald B. MacMillan (United States), 1909–41, made 19 trips to Labrador, Baffin, Greenland.

Richard E. Byrd (United States), 1926, and Floyd Bennett flew airplane from Spitsbergen to the North Pole and back.

Roald Amundsen (Norway), 1926, Lincoln Ellsworth, and Umberto Nobile flew over the North Pole in a dirigible.

George Hubert Wilkins (Australia), 1928, flew over pole from Point Barrow to Spitsbergen.

Umberto Nobile (Italy), 1928, flew over pole in dirigible *Italia;* wrecked, eight lives lost.

Valeri Chkalov and Mikhail Gromov (U.S.S.R.), 1937, made nonstop transpolar flights from Moscow to the United States.

Ivan Papanin and party (U.S.S.R.), 1937, set down by plane on ice floe near pole; studied weather, ocean currents, and sea life; picked up near Greenland.

Ice-Breaker ship *Sedoff* (U.S.S.R.), 1937–40, drifted to 86° 39′.

Carrier *Midway* (United States), 1946, made tests in Davis Strait.

"Exercise Musk Ox" (Canada), 1946, tested Arctic clothing, equipment in northern Canada.

ANTARCTIC EXPLORATION

Jean Bouvet (France), 1739, found Bouvet Island.

Yves Joseph de Kerguélen-Trémarec (France), 1772, discovered Isle of Desolation (Kerguelen Island).

James Cook (Great Britain), 1772–75, circumnavigated Antarctica, found South Sandwich Islands.

William Smith (Great Britain), 1819, discovered South Shetland Islands.

James Bransfield (Great Britain), 1820, believed first to sight Antarctic mainland, near South Shetlands.

Fabian von Bellingshausen (Russia), 1819–21, found Peter I Island and Alexander I Island.

Nathaniel Brown Palmer (United States), 1821–22, explored Palmer Peninsula.

James Weddell (Great Britain), 1823, discovered Weddell Sea and explored surrounding area.

John Biscoe (Great Britain), 1830–32, discovered Enderby Land and Biscoe Islands.

John Balleny (Great Britain), 1839, discovered Balleny Islands and Sabrina Coast.

Dumont d'Urville (France), 1840, found Adélie Coast and Claire Coast.

Charles Wilkes (United States), 1838–42, discovered Wilkes Land; proved Antarctica a continent.

James Clark Ross (Great Britain), 1839–43, discovered Ross Sea, Ross Shelf Ice, and Victoria Land.

Leonard Kristensen, C. E. Borchgrevink (Norway), 1895, first to land on continent (Cape Adare).

Adrian de Gerlache (Belgium), 1897–99, first party to winter in Antarctic (in Bellingshausen Sea).

Erich von Drygalski (Germany), 1901–3, in ship the *Gauss*, discovered Wilhelm II Coast.

Robert F. Scott (Great Britain), 1901–4, spent three winters in first land exploration.

William S. Bruce (Scotland), 1902–4, found Coats Land.

Jean B. Charcot (France), 1903–5, 1908–10; surveyed Palmer Peninsula; found Charcot Island.

Ernest Shackleton (Great Britain), 1908–9; found Beardmore Glacier; went 97 miles near pole. Edgeworth David and Douglas Mawson located south magnetic pole

Roald Amundsen (Norway), 1911, first to reach South Pole (on December 16 from Bay of Whales).

Wilhelm Filchner (Germany), 1911–12, discovered Luitpold Coast and Filchner Shelf Ice.

Douglas Mawson (Australia), 1911–14, explored Adélie Coast; found Shackleton Shelf Ice, Queen Mary Coast.

Robert F. Scott (Great Britain), 1912, reached South Pole January 18, but perished on return trip.

George Hubert Wilkins (Australia), 1929–30, proved Charcot Island an island; first to fly in Antarctic.

Richard E. Byrd (United States), 1928–30; first to fly over South Pole (Nov. 29, 1929); built "Little America" base on Bay of Whales; found Marie Byrd Land.

Douglas Mawson (Australia), 1929–31, charted 300 miles of coast; claimed Enderby Land for Australia.

Hjalmar Riiser-Larsen (Norway), 1929–33, three expeditions; discovered areas in Queen Maud Land.

Richard E. Byrd (United States), 1933–35, made second Antarctic expedition.

Lincoln Ellsworth (United States), 1935–36, explored by air, claimed 300,000 square miles (Ellsworth Highland).

John R. Rymill (Great Britain), 1934–37 explored George VI Sound.

Lincoln Ellsworth (United States), 1938–39, air expedition; claimed 80,000 square miles (American Highland).

Richard E. Byrd (United States), 1939–41, third expedition; mapped a large area south of Pacific Ocean.

Richard E. Byrd (United States), 1946–47, fourth expedition; with Richard H. Cruzen led Navy "Operation High Jump"; flew over South Pole again Feb. 16, 1947.

Finn Ronne (United States), 1947–48, surveyed coast southwest of Weddell Sea.

this route (*see* Hudson's Bay Company). Baffin explored west of Greenland, but for two centuries nobody tried to get farther west.

During this period, the south polar region remained utterly unexplored. About the time of the American Revolution a venturesome Frenchman, Kerguélen-Trémarec, skirted the Antarctic ice, and the English explorer, Captain Cook, spent three years in the region (*see* Cook). Neither found anything of value.

Earlier the Russians had started exploring the limits of their realm. Bering ascertained the break between Asia and North America in 1728 and claimed Alaska for Russia (*see* Alaska). The Russians pushed north in Europe and Siberia to the edge of the Arctic Ocean and later sent charting expeditions into polar waters. In 1819–21 a Russian expedition under von Bellingshausen skirted the fringes of Antarctica.

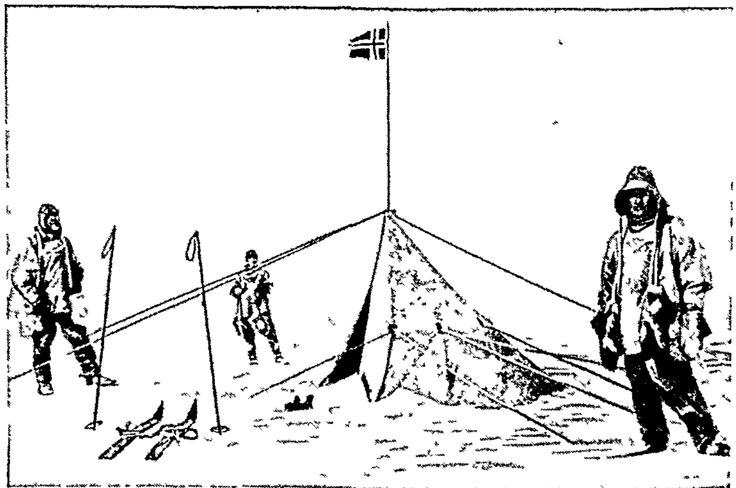
New Interest Brings Tragedies

More than a hundred years ago, men became interested in exploring the Arctic for scientific purposes. Geologists were trying to explain the makeup of the earth, and they wanted to know the arrangement of the polar land and sea. They knew that an Ice Age had once overwhelmed much of Europe and North America, and they hoped to learn more about it by studying Arctic ice. Geographers wanted to find out if they could, why the magnetic north pole was not at the geographic pole.

These motives led to expeditions by ship and across the ice by dog sled. Many of the efforts ended in tragedy. In 1845 Sir John Franklin and 128 others attempted the Northwest Passage in two ships, the *Erebus* and *Terror*. For several years nothing was learned of them. Then, in 1859, a rescue party found bodies on King William Island and a record to April 25, 1848. Not a single man had survived.

VICTORY AT THE TWO ENDS OF THE EARTH

On April 6, 1909, Peary, with his Negro assistant Matthew Henson and four Eskimos, reached the North Pole and hoisted the American flag on a mound of ice. This picture, taken by Peary, shows Henson in the middle.



On Dec. 16, 1911, Amundsen and four comrades reached the South Pole and erected this tent surmounted by the flag of Norway. Inside, the Norwegians left a letter to their king and one to Captain Scott. A month later Scott found these tokens before starting his tragic return trip.

An American tragedy resulted from an international attempt to promote polar research. Representatives from ten nations met in Hamburg, Germany, in 1879, and in Bern, Switzerland, in 1880, and agreed to set up permanent stations in the Far North for scientific observation. The United States agreed to operate bases at Point Barrow, Alaska, and at Lady Franklin Bay on Ellesmere Island. In 1881, an expedition headed by A. W. Greely began work on Ellesmere Island, only 497 miles from the pole. The party gathered valuable information; but two relief expeditions failed to reach them, and 16 of the 23 men died of starvation on Cape Sabine before help finally came.

Forcing the "Passages"

Successes were won as well. In 1850 Capt. Robert McClure in the ship *Investigator* headed east from the Bering Sea to seek the Franklin expedition. The ship was frozen into the ice during three winters, and in the spring of 1853 McClure abandoned it. He led the crew eastward over the ice to Melville Island, where a rescue ship was awaiting them. Thus they traversed the Northwest Passage.

Twenty-five years later a Swedish explorer and scientist, Nils Adolf Erik Nordenskjöld, forced his way through the Northeast Passage. He left Tromso, Norway, in the ship *Vega* in July 1878 and reached Yokohama, Japan, one year and two months later.

Early in the 20th century Roald Amundsen of Norway traversed the Northwest Passage in the ship *Gjöa*. He made the trip after spending 19 months in studying the north magnetic pole, by sailing west in the summer of 1905. His ship was frozen in the ice during

the winter; but next spring he worked it free and pushed through to the Bering Sea and the Pacific.

The Quest for the North Pole

Meanwhile many explorers attempted the seemingly impossible feat of reaching the North Pole. A Norwegian scientist, Fridtjof Nansen, noticed that objects such as driftwood and a pair of trousers from a wrecked steamer were carried by drifting ice across the Arctic Ocean from Asia to the North Atlantic. In 1893, he and 13 companions let their ship *Fram* be frozen into the ice pack north of Siberia. Then for three years they slowly drifted westward; but the drift carried them wide of the pole. Nansen and one companion left the ship and dashed across the ice with a dog sled but they were unable to get farther north than 86° 14′. In 1896 the ship finally came out of the ice pack north of Europe.

SHELTER AND TRAVEL IN THE ARCTIC

Here are two photographs taken by one of Donald MacMillan's expeditions into the Arctic. The top picture shows an Eskimo summer shelter made of animal skins, and rocks to keep the skins from blowing away. In the bottom picture, a dog team pulls a sledge over the frozen snow.

In 1897 Dr. Salomon Andrée of Sweden and two companions tried to drift over the pole in a balloon. Nothing was heard of them for 30 years. Then a Norwegian explorer, Dr. Gunnar Horn, found a photograph taken by one of the party, showing the balloon wrecked on White Island. (The photograph is reproduced later in the article.)

Robert E. Peary, the first man to reach the North Pole, had spent 18 years in earlier Arctic exploration. Finally, on his eighth trip, April 6, 1909, he reached the pole (*see* Peary). Before the world received the news the next September, another American, Dr. F. A. Cook, arrived in Copenhagen, claiming that he had reached the pole from Greenland on April 12, 1908. Peary and others challenged Dr. Cook's story and it was soon discredited. The test of being at the pole consists of seeing the sun and stars going around the sky in horizontal circles. Peary had 32 observations which met this test; but evidence was found suggesting that Cook's record of observations had been made up beforehand.

Two other 20th century explorers who devoted their lives to exploring and studying the nature of the Arctic are Donald B. MacMillan, a United States scientist, and Vilhjalmur Stefansson, a Canadian. Stefansson's voluminous writings about the "friendly Arctic" helped to convince the world that trans-Arctic air lines were feasible.

New Interest in the Antarctic

After Peary reached the North Pole, explorers turned to the Antarctic. Many earlier expeditions had skirted the coast, and one under Ross of the British Navy discovered the ice-locked Ross Sea which many later expeditions used for landings. One landing had been made by a party of Norwegians under Kristensen. Now Scott and Shackleton of the British Navy led expeditions; and many explorers wanted to reach the South Pole.

The first to succeed was Amundsen. In 1910 he reached the Ross Sea in Nansen's ship *Fram* and wintered on the Bay of Whales. He spent the following summer establishing three depots of food and supplies on the way to the pole, then took shelter for another winter. On Oct. 29, 1911, he started his final dash with four companions and four dog sledges. On Dec. 16, 1911, they reached the pole. After three days they returned to the base camp, making the round trip journey of 1,860 miles in 99 days.

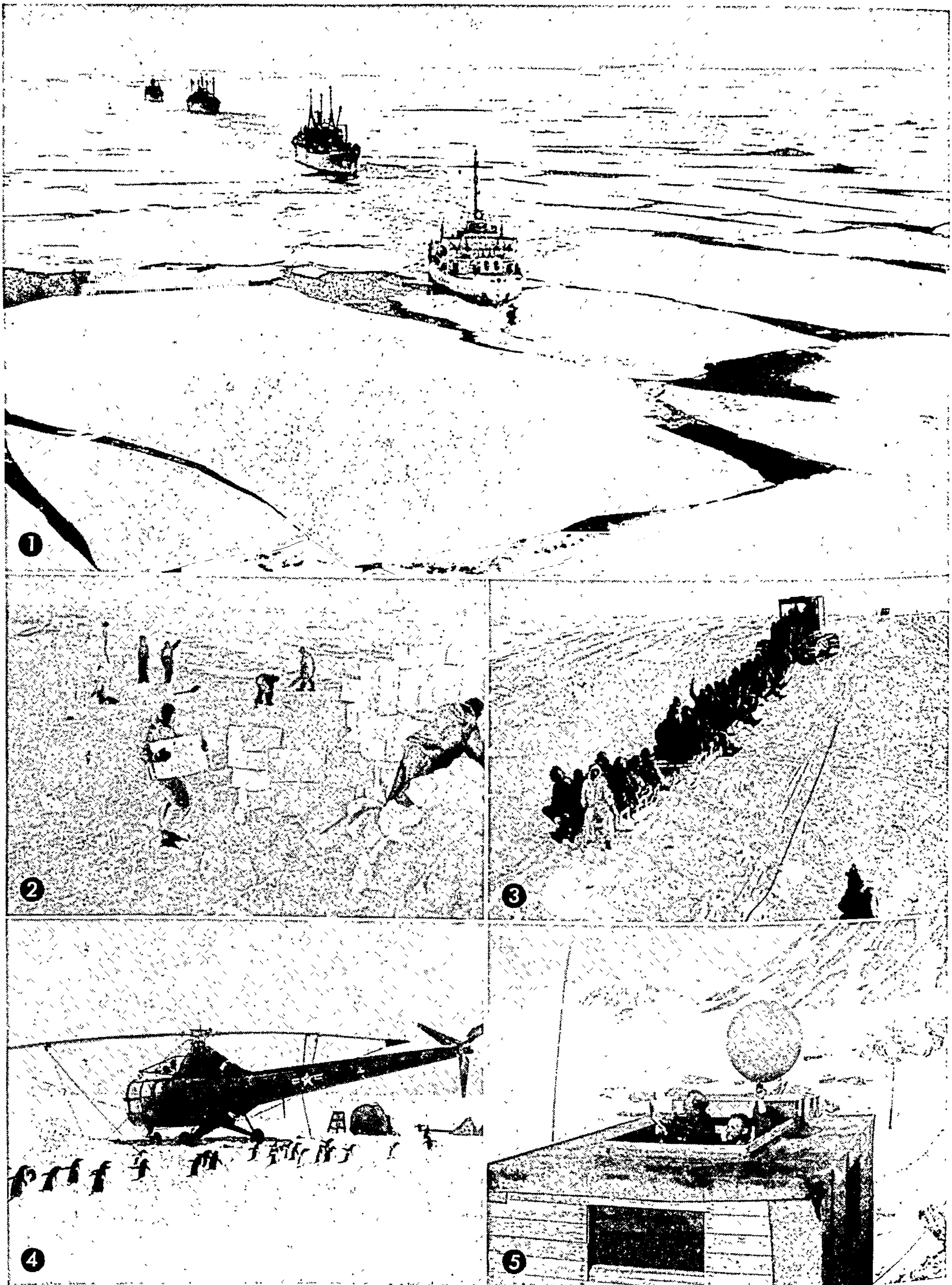
Meanwhile Scott had started his journey. He reached the pole Jan. 18, 1912, only to find that Amundsen had arrived ahead of him. He and his party perished tragically in violent blizzards on the return journey (*see* Scott, Robert F.).

The Airplane Creates a New Era

Soon after the conquest of the South Pole, the first World War interrupted all exploration. But it also brought development of the airplane to a level which made it useful for polar exploration.

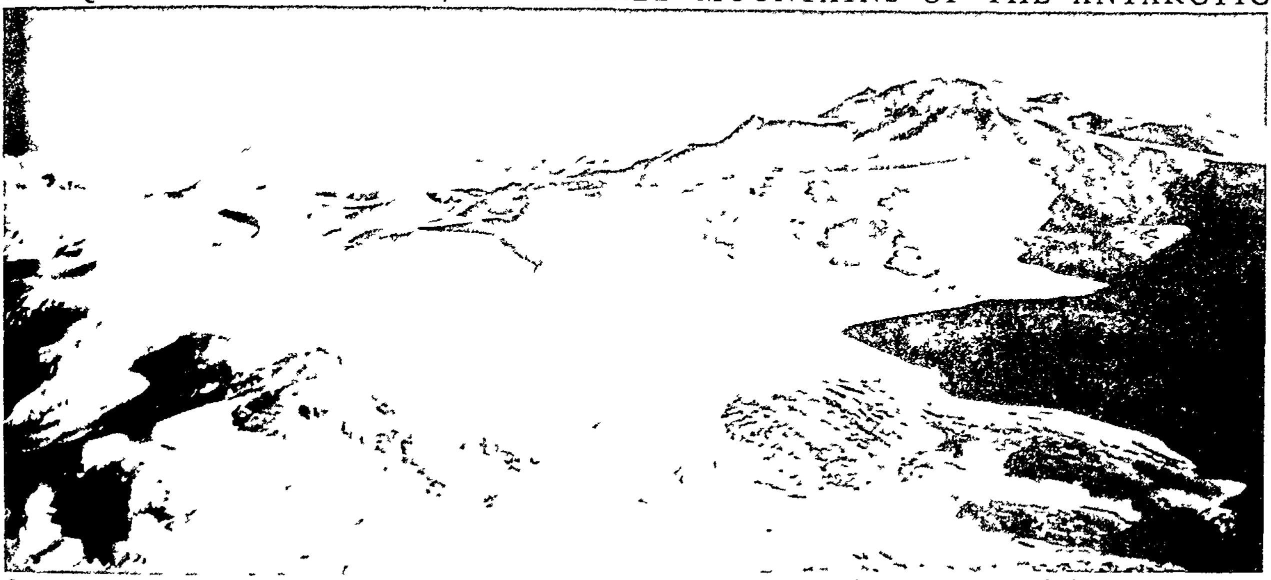
Richard E. Byrd of the United States Navy led in using this new aid by flying over the North Pole May 9, 1926, in a plane piloted by Floyd Bennett. Amundsen and Ellsworth followed three days later in a dirigible piloted by Umberto Nobile of Italy. Nobile tried again in 1928, but his dirigible was wrecked after he reached the pole. Amundsen perished in a rescue flight by airplane. A new era of transpolar flying began in 1937 when Russian pilots twice flew

MODERN METHODS OF POLAR EXPLORATION



1. The steel-hulled *Northwind* clears a path through the ice for other ships of the United States Navy's Antarctic expedition of 1946–47. 2. Polar explorers now build huge snow igloos to serve as airplane hangars. 3. Tractors with special caterpillar treads pull sleds through the snow. They are faster than dog teams. 4. Here penguins inspect a Navy helicopter used by the 1948 expedition. 5. Scientists gather weather data by releasing a balloon. They use a theodolite to follow the balloon's course.

THE QUEEN MAUD RANGE, ICE-LOCKED MOUNTAINS OF THE ANTARCTIC



On his historic flight over the South Pole on Nov. 29, 1929, Admiral Byrd had to cross this perilous mountain barrier, ribbed with ice and gnawed by fierce winds. Forced landing on such slopes meant death. The photograph was taken from Byrd's plane.

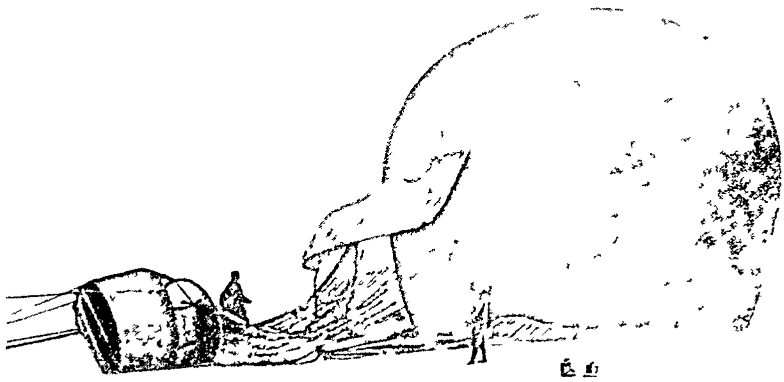
single-engined monoplanes nonstop from Moscow to the United States over the North Pole.

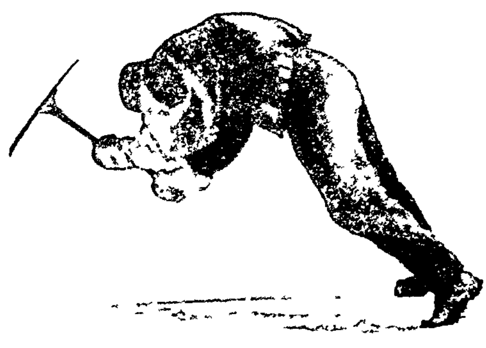
But the Antarctic drew more attention because the vast stretches of unknown land offered chances to make discoveries and establish national claims to territory. In 1928, Byrd set up a base camp, "Little America," on the Bay of Whales, and on Nov. 29, 1929, he and two companions flew over the South Pole. In a second expedition (1933–35) he made intensive use of scientific aids, including geophysical soundings to test the thickness of ice. On his third expedition (1939–41) he made ground trips in a tractor "snow cruiser," equipped with special caterpillar treads for land trips.

Another Antarctic explorer by air was Lincoln Ellsworth. In 1935–36 he flew over 300,000 square miles of land in Ellsworth Highland and claimed the region for the United States. In 1939 Ellsworth and his pilot, Herbert Hollick-Kenyon, made flights without a base by alighting on the ice. They worked from Dundee Island to Little America in 13 days.

After the second World War, exploration was resumed, both for scientific studies and to bolster claims for territory. Great Britain, France, Norway, Australia, Argentina, Chile, and other nations claimed land (*see* Antarctic Continent). In 1946–47 the United States Navy sent out a huge training and research expedition under Admirals Byrd and Cruzen. Thirteen ships, including a submarine, transported 4,000 men. Two groups sailed around Antarctica and photographed the coast lands by airplane. A third group made surveys from Little America about 600 miles in all directions and over the South Pole. In 1947–48, Commander Finn Ronne, U.S.N.R., surveyed the coast of the Weddell Sea. An international expedition from Norway, Great Britain, and Sweden explored Queen Maud Land in 1949–52.

SOLVING THE MYSTERIES OF THE POLAR REGIONS





The upper picture shows the tragic end of Andrée's attempt to reach the North Pole by balloon. The picture was taken July 14, 1897, near White Island, by one of the party. In 1930 Dr. Gunnar Horn, a Norwegian, found the camera with the picture. Below, a member of a Mawson expedition (1929–30) leans against an Antarctic gale to swing a pick.

Directing traffic

How POLICE *Protect* LIVES *and* PROPERTY

POLICE. Wherever people live together they must have laws and policemen to enforce the laws. The police have two main duties. One is to keep people from breaking laws. The other is to arrest lawbreakers. By carrying out these duties the police protect lives, health, and property. They stop disturbances, control traffic, and work generally to keep the community safe.

Some policemen have a specialized job such as that of photographer or fingerprint expert. But most policemen must deal with every kind of emergency that arises. In dealing with criminals they often risk death. Every year many policemen are killed as they protect the public against harm or theft.

The Neighborhood Policeman

One of the policemen that city people see often is the neighborhood patrolman. He walks a regular route called a *beat.* Spaced along his beat are special telephone boxes attached to posts or buildings. Over these *call boxes* the patrolman reports regularly to the desk sergeant or other officer at his station house. If he needs help, he can call for it from the nearest call box.

The patrolman keeps alert as he walks his beat. During the day, he may stop mischief-makers from breaking windows, help a stranger on his way, or aid a person taken suddenly ill in the street. In crowds he watches out for pickpockets and purse snatchers. He warns property owners or tenants to cover garbage cans and clean up litter. He takes charge of a lost child and helps old people cross the street. He keeps a sharp lookout for known criminals.

Giving first aid

When children crowd the streets on their way to and from school, the patrolman sees that they get safely across busy intersections. In this he is helped by schoolboy patrolmen or by special guards at corners where school children cross busy streets. He spends part of his day instructing the patrol boys and guards.

The patrolman on the night beat tries the doors of stores to see that they are locked. He quiets loud parties and noisy people on the street. Sometimes he comes upon a criminal in the act of robbing a house or store or stealing an automobile. Then he draws his pistol and does his best to capture him. If he needs help he blows loud blasts on his whistle.

Day or night, the patrolman is called upon to act in the face of crisis or danger. To do this, he must be physically fit and must be skillful at such things as marksmanship and first aid. Above all, he must understand human nature.

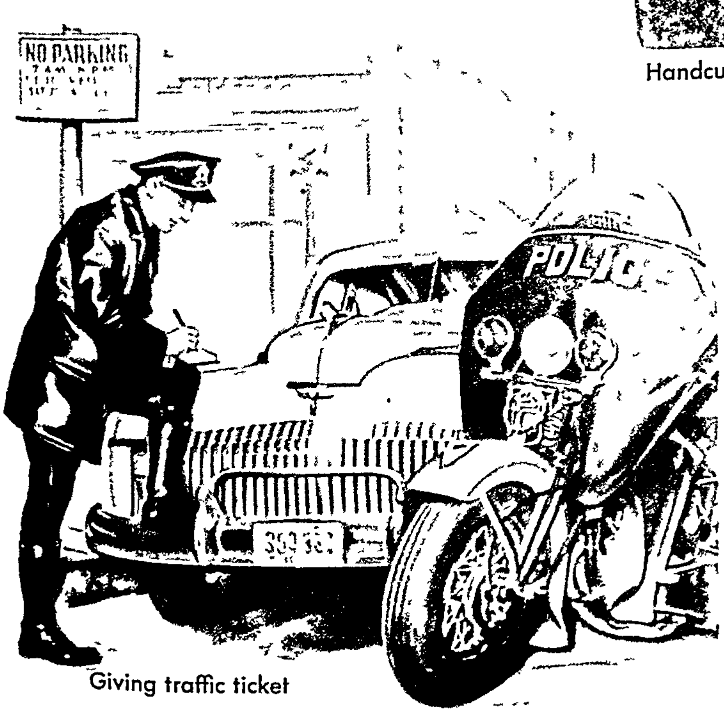
Squad Car Policemen

In most small cities and in less thickly settled sections of large cities, the streets are patrolled by policemen in *squad cars*. The cars are equipped with two-way radios, and over these the policemen keep in constant touch with their headquarters. Another patrol car is the *squadrol*, also equipped with two-way radio. The squadrol looks much like an enclosed (panel) delivery truck. It carries a stretcher and can be used as an ambulance or to transport prisoners. Both the squad car and the squadrol are light, fast cars. Some of them are specially equipped for swift acceleration ("pickup").

One or two policemen in a squadrol or squad car can patrol a much larger beat than a patrolman can on foot. A radio message from police headquarters can quickly send them to the scene of a crime, riot,

Training patrol boys


Handcuffing a fighting prisoner



Giving traffic ticket


Helping a lost child

or fire. There they can keep headquarters informed by radio of events as they occur.

Controlling Traffic on Roads and Streets

The *traffic policeman* works to keep cars and trucks moving steadily and at the proper speed along the streets. He also must see that people on foot can cross intersections safely. The traffic policeman enforces regulations designed by specialists in his department. These specialists decide where stop signs shall be placed and what streets shall be designated as "through" or "one way" streets. They also make parking and speed-limit rules. Some traffic policemen direct the flow of traffic at busy intersections. Others patrol well-traveled streets and boulevards in motorcycles or cars.

TRAINING FOR ACTION

Policemen must learn to overpower prisoners who fight. Here a police trainer is teaching a patrolman a form of Japanese wrestling called judo or jujitsu.

The traffic police use two types of motorcycles: the *solo* (two-wheeler) and the *three-wheeler*. Often both are equipped with radio. The solo is used to overtake speeding cars, to guard the lines of a parade, or to clear the traffic ahead of an ambulance or a car bearing an important visitor to the city.

But the solo motorcycle is more liable to accident and its use for chasing speeders is declining. The three-wheeler threads through traffic in the busiest parts of the city. The policeman checks parking violations and helps to keep traffic moving. By radio he can be dispatched to the scene of a traffic jam.

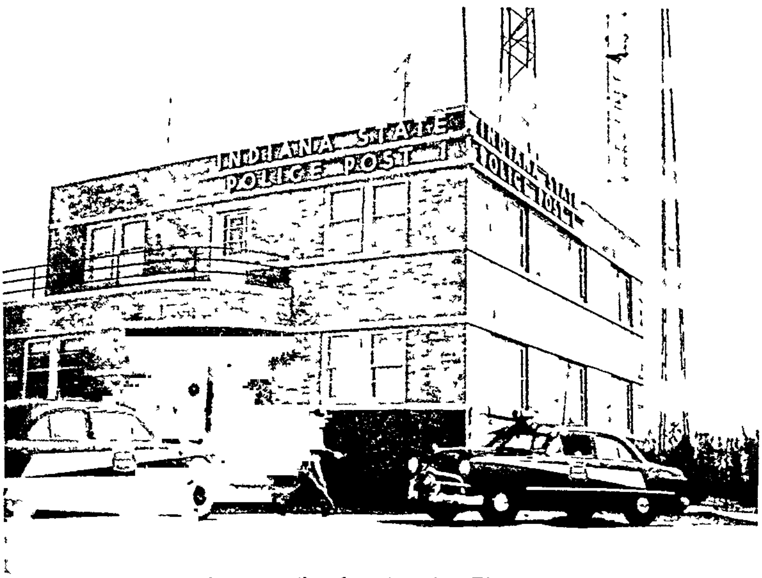
Traffic control cars watch for speeders and help drivers of stalled cars to move out of the stream of traffic. These have two-way radios and can call for help as it is needed. They can also receive reports of accidents from their headquarters. Like all policemen, traffic control men are trained in first aid. But their chief duty at an accident is to investigate the cause. They often take pictures of the wrecked cars or trucks. These may be used later as evidence in court trials.

Women in the Police Department

Larger police departments have policewomen as well as policemen. Policewomen who watch crowded playgrounds or guard street crossings near schools usually wear uniforms. But most policewomen wear ordinary street dress. Many of them work as detectives and do not wish to reveal that they are members of the police department.

Some policewomen patrol the busy streets watching for purse snatchers and other thieves that prey on women. Other policewomen visit bus and railroad stations looking for runaway children. They also visit places with bad reputations to warn away young girls. The job of the policewoman is to prevent women and children from getting into trouble. But sometimes the policewoman acts as a detective in catching a woman criminal.

A STATE POLICE BARRACKS



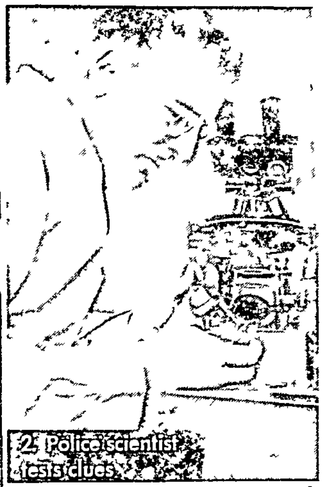
Many states have their own police departments. The state policemen are called *troopers* and their stations are called *barracks*. Most of the barracks are on highways away from towns. Here two troopers are starting to the scene of an automobile accident. When they reach the spot, they can call for help by two-way radio.

How Detectives Work

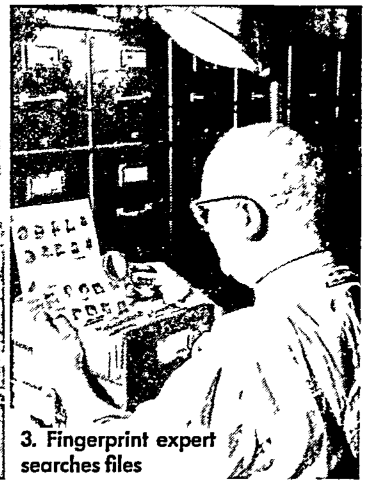
The uniformed policeman works for the most part to *prevent* crime and disorder. The *detective* works to investigate crimes already committed and to find and arrest the criminals. Like the policewoman, he often must hide the fact that he is a member of the police department. Therefore he wears street clothes and conceals his badge and gun. For this reason he is often called a *plain-clothes man*.

In larger cities, detectives specialize in one kind of crime. Some will work only on homicide (murder or manslaughter) cases. Others work on particular kinds of robbery, such as silk or fur thefts, car thefts, or "hijacking" (stealing merchandise from large trucks along the highways). Large cities have a *narcotics* detail to suppress use of harmful drugs. Some detectives specialize in crimes

1 Police examine robbed safe for clues



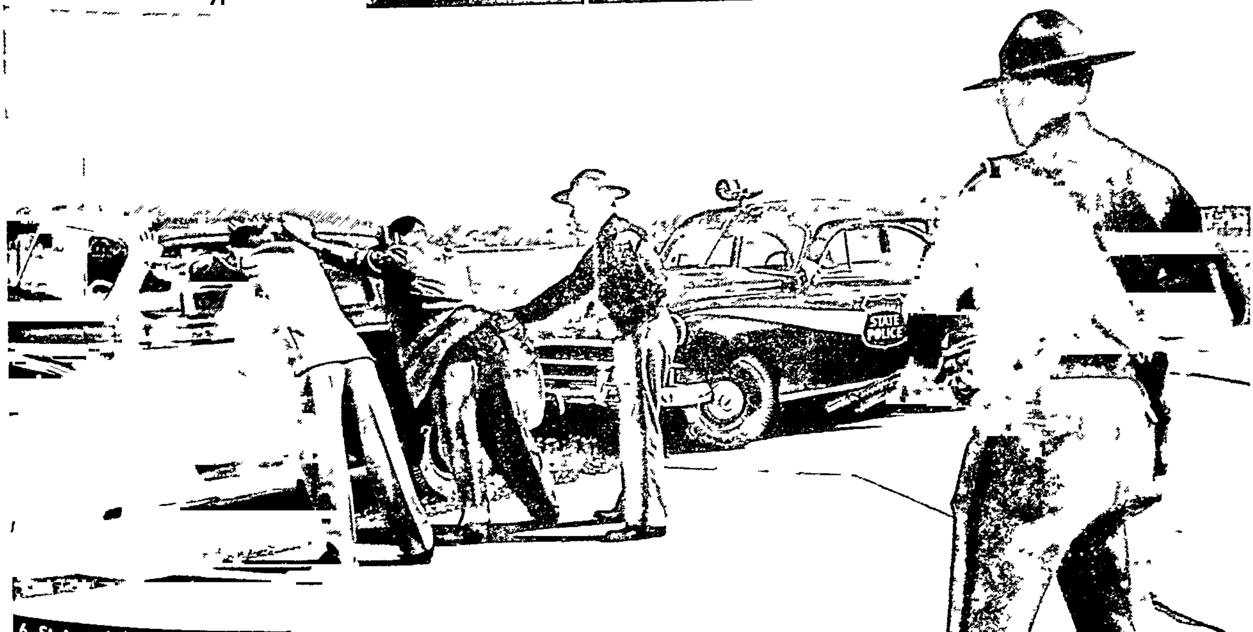
2. Police scientist tests clues



3. Fingerprint expert searches files

4 Police send out teletype alarm

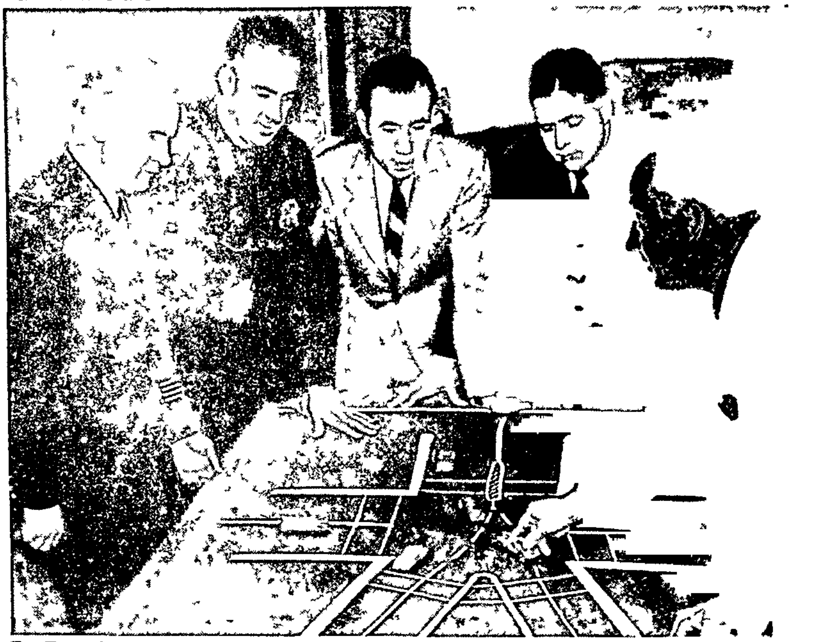
5. State police get radio alarm



6. State police capture robbers

These pictures show steps in capturing a gang of safe robbers. 1 An office safe has been blown open by robbers. Robbers always leave clues. The police find a fingerprint. 2 The police laboratory tests other clues. 3 An expert finds that the fingerprint belongs to an ex-convict named Joe Smith. 4 An alarm goes out: "Arrest Joe Smith!" The alarm is sent over the teletype and police radio. 5 State policemen get the alarm. They see Joe in a car with another man. They stop Joe's car. 6 The policemen order Joe and the other man to put their hands high on the car. One trooper covers them with a shotgun. The other searches the prisoners. He finds a pistol in Joe's pocket. Then the troopers take the prisoners to jail.

TRAFFIC EXPERTS SOLVE A TRAFFIC PROBLEM



Traffic policemen come from all over the world to Northwestern University's Traffic Institute to study traffic control. Here a group of policemen work out a traffic problem with toy cars and a street map painted on a table.

committed by swindlers and forgers. Others who speak a foreign language work in districts where this language is spoken.

Emergency Squads and Their Work

Accidents happen everywhere and often special skill and equipment are needed to deal with them Large city departments have emergency squads that help in these cases. Perhaps a worker is caught between a freight car and a platform or a cat is afraid to come down from a tree or telephone pole. A child may lock himself in a bathroom and must be released. To rescue them, an emergency squad has a truck with many kinds of equipment It has strong jacks for lifting heavy objects, acetylene torches for cutting metal, ladders, sledges, axes, shovels, and rope Gas masks are carried for use when cooking gas or other poisonous fumes have filled a room. Floodlights help in dark places or at night. Oxygen tanks and stretchers are ready for injured persons In many cities, fire departments share in this work.

Work at Headquarters

Every police department has a *headquarters* building, with offices for executives, detectives, and other specialists. Larger cities also have *precinct* stations in various districts. Each station has a complaint room and desk for receiving reports of crime or trouble. A squad room accommodates the patrolmen of the district, and blocks of cells or separate jails are provided for confining suspected criminals awaiting charge or trial.

In large cities the *records* division keeps fingerprints and histories of known criminals. If a fingerprint cannot be matched in the file, a copy can be compared with the national master file in Washington, D.C. (*see* Federal Bureau of Investigation; Fingerprints). A criminal's history often reveals a peculiar working method that helps solve a crime.

The *crime laboratory* tests bloodstains, dust, clothing, and other materials for clues. Bullets can be

YOUR COMPLAINT AND THE PATROLMAN'S REPORT

The central complaint room of a big city's police department receives emergency calls. Missing persons and stolen car complaints will be sent on to station houses by teletype. If a robbery or other crime is reported, radio messages will send squad cars to the scene. At the right a foot patrolman reports from his beat to his desk sergeant.

ORGANIZATION OF A CITY POLICE DEPARTMENT

COMMISSIONER or CHIEF

- **UNIFORMED POLICE**: Patrolmen; Squad Cars; Emergency Squads; Police Ambulances; Policewomen
- **DETECTIVE**: Investigators; Special Squads (murder, robbery, etc)
- **RECORDS**: Identification Files (fingerprint, photograph, etc); Property Custodian (keeper of stolen goods, prisoners' valuables, etc); Communication (radio, teletype, telephone); Crime Laboratories (chemistry, gun and bullet tests, etc); Crime Prevention
- **TRAFFIC**: Accident Prevention; Traffic Directors; Patrol Cars; Motorcycles; Schoolboy Patrol
- **TRAINING**: Physical Training; Target Ranges; School of Law and Ordinances (rules of evidence, police methods, etc)

This chart shows how a city's police force is divided into departments. The men in the departments are trained for their special work.

traced to the weapons that fired them. (This work is called *ballistics.*) Chemicals can restore the serial number and motor number of a car after thieves have burned them off. Lie detectors may be used to test the truthfulness or falseness of statements made by persons under suspicion.

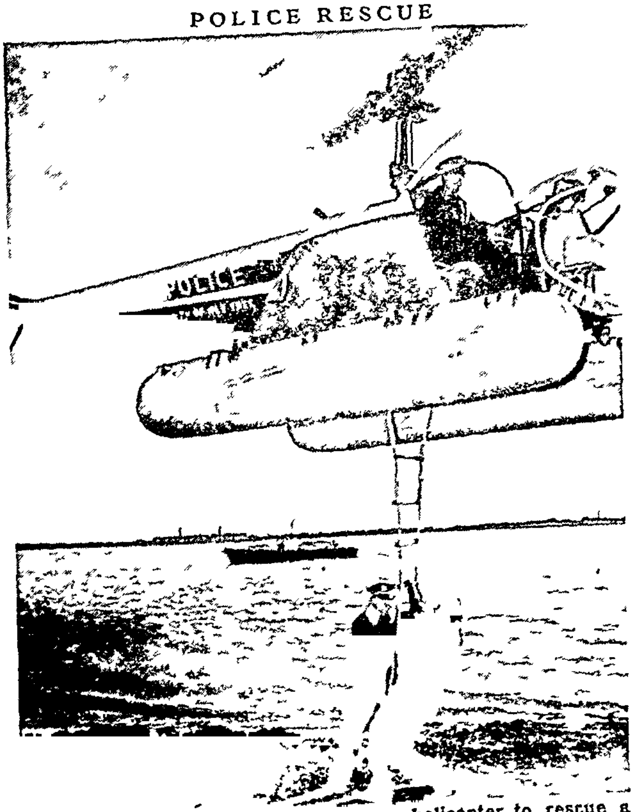
Everyone in the department is kept in contact with each other by the *communications system*. In small cities, calls come to precinct stations or headquarters. Large cities have a *complaint room.* Telephoned complaints come here, and the officers on duty use radio to send squad cars to investigate. They use telephones or teletype machines to inform precinct stations, and if necessary other cities and states, of trouble.

Preparing to Be a Policeman

Young men (or women) who want to join a police force must first pass a mental and physical examination. If they are accepted they become *probationary* policemen in the *training* division. They study law, city ordinances, and collection of legal evidence. They take strength-building drills and learn how to climb walls and overpower criminals. They learn to shoot and care for revolvers and to use tear-gas guns, shotguns, and submachine guns.

Well-trained policemen know that many juvenile delinquents become adult criminals. Many departments try to prevent this by showing young people that crime does not pay. They give lectures and show motion pictures. They may organize boys into forces of *junior policemen.* Police work is explained and the boys learn how they can help in law enforcement. Many police forces support teams and tournaments for baseball, football, basketball, and other sports.

POLICE RESCUE



Here New York City policemen use a helicopter to rescue a man stranded on a sandbar by the ocean tide. Police rescuers in large cities use helicopters, airplanes, emergency trucks, and ambulances to bring help in emergency cases.

Outside of cities and towns, protection is provided by *county* police and *state* police A county police force is commanded by the sheriff of the county. A state police force has a director, usually appointed by the governor. The men of a state police force usually are called *troopers.* They patrol highways and help small-town and county police. They watch for overloaded trucks, which damage the highways. Not all states have their own police forces. Among the better-known state police are the *Texas Rangers* and the troopers of Pennsylvania, New York, Michigan, Indiana, and California.

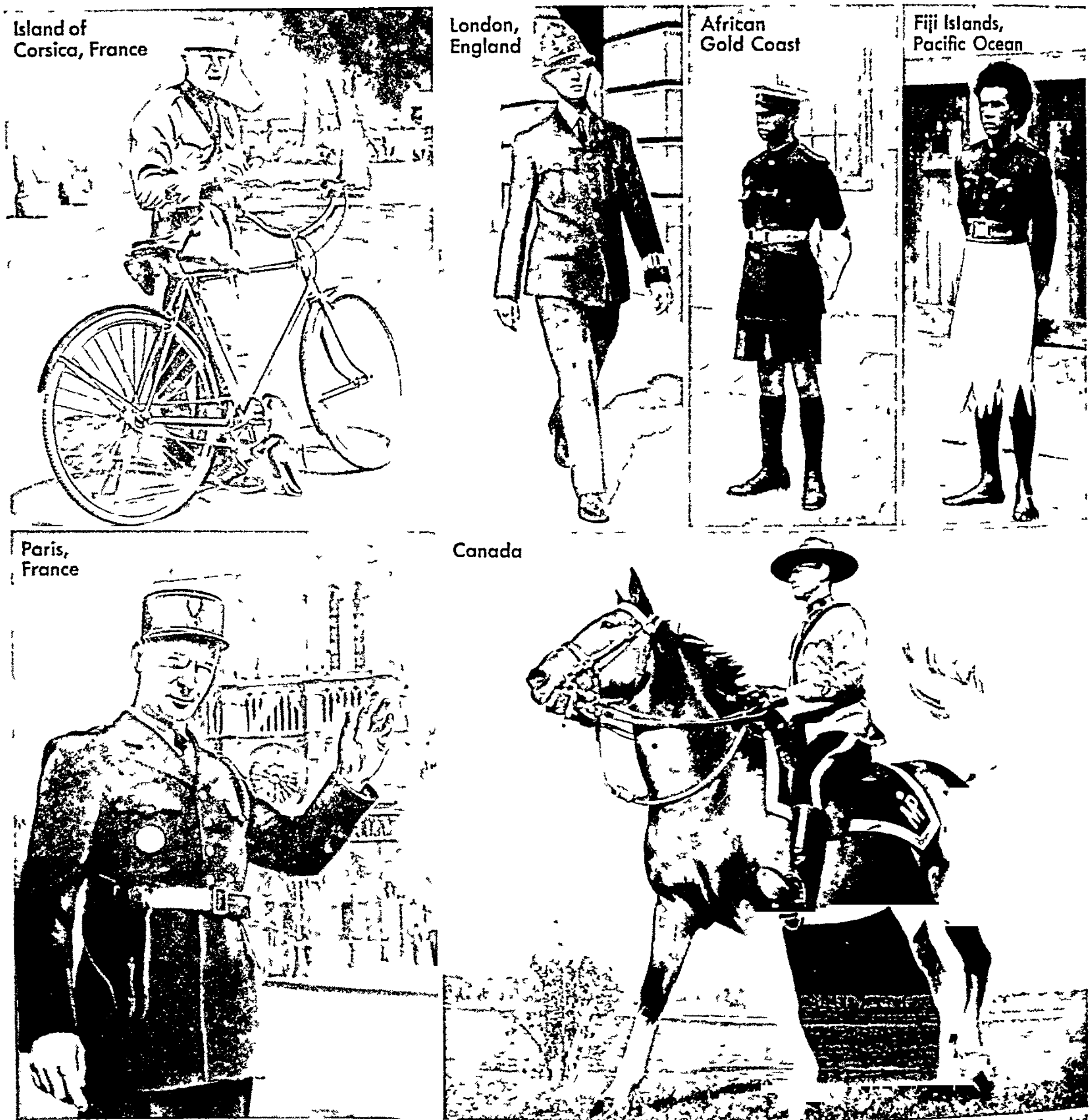
The national government has several police forces. The best known of these is the *FBI* (*see* Federal Bureau of Investigation). Other national police include the *Secret Service* and the *T-men* of the Treasury Department, the *Border Patrol,* and the *Postal Inspectors.*

Some Foreign Police

Canada's local and provincial police resemble those of cities and states of the United States. The national force is the *Royal Canadian Mounted Police.* The London detective force, with headquarters at *New Scotland Yard,* is famed the world over.

In totalitarian nations (often called *police states*) the police help terrorize people into submission. The Soviet Union has a national police called the *MVD.* This force works secretly to discover and punish all who are suspected of disloyalty to the government. The MVD maintains a large force, trained like an army to use tanks, artillery, and

POLICEMEN OF MANY NATIONS



A traveler going from country to country, sees policemen wearing many different kinds of uniforms. The Royal Canadian Mounted policeman is shown wearing his dress uniform. His working uniform is not so showy.

airplanes. Nazi Germany and fascist Italy made similar use of national police forces.

How Modern Police Forces Developed

Throughout history civilized nations have maintained some kind of police. The very word "police" comes from the Greek *polis,* meaning "city." The first modern force was organized in London.

The policemen of London are called "bobbies." This nickname arose because the force was organized in 1829 by Sir Robert ("Bobby") Peel. American policemen are often called "cops." The word came from the way the early policeman (called a *constable*) signed reports. After his name he printed the letters "C.O.P." They stood for "constable on patrol."

In colonial times and in the early days of the United States, cities did not have good police forces. Men were appointed to "watch" and "ward." The watch worked at night, the ward during the day. New York City organized the first city police force in the United States in 1844.

In early years of American police development, policemen were appointed by politicians. Many appointees were unfit for the work. Theodore Roosevelt, as commissioner of New York City police, pioneered in bringing policemen under civil service rules (*see* Roosevelt, Theodore). This began a nation-wide movement to have well-trained policemen and scientific methods of crime detection.

The DONKEY *and* ELEPHANT *of* POLITICS

POLITICAL PARTIES. Whenever men have had democratic government, they have organized political parties. Such parties existed even in ancient Athens and republican Rome. In modern democracies, thousands or millions of voters form into political parties to elect candidates who will express their views.

The United States Constitution makes no provision for political parties. The first president, George Washington, believed that they were unnecessary and a menace to federal authority. But under democratic rule it was only natural for voters with similar political beliefs to band together to achieve their aims.

For many years political parties received no formal recognition. Political lines were drawn on the basis of a single issue or the personality of a leader. But gradually modern parties began to evolve. In most years two major factions competed for control of the government. Today one major party is the Democratic; the other is the Republican, often called G.O.P. (Grand Old Party).

THE BIRTH OF PARTY SYMBOLS

The first Democratic donkey was drawn by Thomas Nast in 1870. At first it represented the copperhead (antiwar) faction, but later it became the symbol for the entire party.

The Republican elephant was also created by Thomas Nast. This cartoon, published in 1874, shows the party on the brink of a pitfall, partly due to the false charge of Caesarism.

Work of Political Parties

Political parties strive to win and hold control of the government by electing their candidates to office. They present political issues and candidates for office to the voters; and the voters, after hearing the arguments on each side, choose as they think best. The victorious party (the "ins") assumes the responsibility for its administration and its candidates. Meanwhile the "outs" can offer criticism of the government and thus serve as a check on its actions (*see* Democracy).

To carry on its work each political party has its own organization, or "party machinery." The national organization resembles a huge pyramid. At the broad base of the structure are citizens who usually vote for the party. The next level consists of local party officials. These officials choose the state officers of the party. Each state organization, in turn, names its two representatives to a *national committee*. From this group, 10 or 15 members are selected to form an *executive committee*. At the top of the pyramid is the *national chairman*, chosen by the party's current nominee for president.

Party machinery is most active during presidential campaigns and during "off-year" elections of some congressmen and state and local government officials. Between elections the machinery works quietly on all levels to build influence for the next election.

All election victories depend upon the all-important work of the local organizations—the "grass roots" of politics. The basic unit of local organization is the *precinct* or *election district*. It may have a hundred voters or less in rural areas, or several hundred in cities.

The chief party official in the precinct is the committeeman or "captain." His job is to win friends for his party and to "get out the vote" on election day. He schedules social events, assists the distressed, recommends party members for political jobs, and provides transportation to the polls on election day. All this work must go on continually to help the captain "carry the precinct" for his party.

In rural areas the next higher level of organization is the county. In cities the next level is the ward. County *chairmen* and ward *committeemen* are important, for they distribute local political jobs and favors (called "patronage").

Above these organizations are others for city, congressional district, state, and national levels. Each coördinates the work of its subdivisions, plans campaigns, raises money for campaign expenses, and distributes state and federal patronage.

The National Conventions

In the spring of a presidential election year state delegates from each party are chosen to attend the national conventions. They are named by state party conventions or elected in presidential primaries (*see* Primary Elections).

The national committee of each party establishes the number of state delegates. The Democratic party allots each state two delegates for each congressional district, two for each senator, and two for each representative elected at large. Four additional delegates go to each state that voted Democratic at the preceding presidential election.

The Republican party allots each state four delegates, plus two other delegates for any congressman elected at large. A state also receives three extra delegates if it voted Republican at the preceding presidential or senatorial election. In addition, a state gets one delegate for each congressional district that has 1,000 Republican voters, with one extra delegate for 10,000 Republican voters. The Republican party

uses this method of apportioning delegates because it has little strength in the South.

Both parties also assign delegates to the District of Columbia and to United States territories and possessions. For the 1952 conventions the Democrats selected 1,230 delegates; the Republicans about 1,200. (For a list of national conventions since 1900, *see* **Conventions** in the FACT-INDEX.)

Each party holds its convention in some large city in midsummer (both parties chose Chicago for 1952). Here the party nominees for president and vice-president are chosen, the party platform is drafted, and the national committee is selected. (For the manner in which presidents are elected, *see* Elections; President.)

Regulation and Criticism of Parties

To control excessive spending by political parties Congress passed the Corrupt Practices Act in 1925. This law limits campaign expenditures of senatorial candidates to $25,000 and of House candidates to $5,000. The Hatch Act of 1939–40 prohibits political activity by government employees paid with federal funds. It limits single campaign contributions to $5,000. And it sets the maximum party spending for a presidential election at 3 million dollars. Federal laws, however, cannot curb local or private spending. As a result a total of more than 30 million dollars is usually spent on the presidential campaigns of the two major parties.

American political parties have also been criticized on other grounds. Both parties write their platforms to influence as many voters as possible and to offend the least number. This tends to submerge important issues. Parties usually make appointments to public office on the basis of party membership rather than on merit (*see* Civil Service). And at times a strong party "boss" has controlled a local government.

A boss gains control as a rule when a large portion of the voters are indifferent to political issues and operations. Many vote as the precinct captain asks, in return for help in making a living or for smoothing over minor difficulties with the law. As a result the precinct captain can "deliver" the vote as the boss directs. Often the boss holds no office or title and thus bears no responsibility for his actions. The whole structure is called a "machine." Perhaps the most famous example was the Tammany machine that controlled New York City for many years.

If voters become aroused over misuse of political power, they can defeat the machine candidates at election time. Such victories usually require concerted action and hard campaigning on behalf of the anti-machine, or "reform," candidates.

DEMOCRATIC CONVENTION MAKES HISTORY

Delegates from many states crowd near the speaker's platform to hail the renomination of Franklin D. Roosevelt for president in 1944. He was also the only United States president to win four terms.

First Political Parties in the United States

During the American Revolution the people who supported the revolt called themselves Whigs; those who remained loyal to England were called Tories. After the Constitution was ratified the new nation seemed united in policy. But soon clashes between Alexander Hamilton and Thomas Jefferson, both then in President Washington's Cabinet, began to divide public opinion into two factions. Hamilton's party, the Federalists, wanted a strong central government with implied powers stemming from loose interpretation of the Constitution. Jefferson's followers, the Democratic Republicans, believed in rigid "states' rights," based on strict interpretation of the Constitution.

In 1796 the two parties in Congress held caucuses which made nominations for president. The result was a Federalist president, John Adams, and a Democratic-Republican vice-president, Thomas Jefferson. In 1798, Adams tried to halt criticism of his party by signing the Alien and Sedition Acts (*see* Adams, John). Popular resentment against these laws resulted in the election of Jefferson, a Democratic Republican, in 1800; and the Democratic-Republican party held power for the next 28 years.

During these years, circumstances brought changes in the political philosophies of the party. John Marshall, chief justice of the Supreme Court, and other Federalist-appointed judges continued to give more power to the national government. And in the case of the Louisiana Purchase and the Embargo Act of 1807, President Jefferson gave a liberal interpretation to the Constitution (*see* Embargo Acts; Louisiana Purchase). Meanwhile the Federalist party disappeared as a political force chiefly because of opposition to the War of 1812 (*see* War of 1812).

During the 1820's the Democratic Republicans split. Conservative Eastern elements of the party advocated nationalism, protective tariff, and a national bank. They called themselves National Republicans. The other wing of the party represented the South and West. This group stood for states' rights, tariff for revenue only, and an independent treasury. It took the name Democratic and elected its leader, Andrew Jackson, in both 1828 and 1832 (*see* United States, History, section "The Westward Advance").

During Jackson's first administration the Anti-Masons originated the national nominating convention, held at Baltimore in 1831. The Democrats fol-

lowed this example by holding their first national convention in 1832, also at Baltimore.

Rise and Fall of the Whigs

By 1836 the National Republicans and other anti-Jackson factions had formed a new party called the Whigs. They lost to the Democrats that year, but in 1840 the Whig candidate, Gen. William Henry Harrison, was elected president. Much of the Whig success was due to a colorful campaign featuring torchlight parades, log-cabin floats with free cider, and a song 'Tippecanoe and Tyler Too'.

In 1844 the Whig candidate, Henry Clay, lost to James Polk. But four years later another noted general, Zachary Taylor, won for the Whigs. The Whig leaders, however, doomed their party in 1852 by taking a compromising stand on the slavery issue. During the next few years most of the southern members joined the Democrats, while the northern Whigs helped form a new antislavery party, the Republican.

Republican and Democratic Rivalry

The passage of the Kansas-Nebraska Act in 1854 alarmed the North. The same year small groups of men gathered at Ripon, Wis., Jackson, Mich., and elsewhere to urge creation of a new party opposed to the extension of slavery. Two years later, the newly formed Republican party meeting at Philadelphia chose John C. Frémont for president. Frémont lost to the Democratic nominee, James Buchanan. But by 1860 the Democrats were widely split on the slavery issue, and Republican Abraham Lincoln was elected president.

The Republicans emerged from the Civil War with great political strength. They controlled the national government for the next 72 years except for the 16 years when presidents Grover Cleveland and Woodrow Wilson represented the Democratic party.

The Democrats started a long period of national success in 1932. Franklin D. Roosevelt became the first president to serve a third term; and in 1944 he won election to a fourth term. In 1948 the Republicans polled more electoral votes (189) than they had in 20 years. But their candidate, Thomas Dewey, lost to Democrat Harry Truman in one of the greatest political upsets in history.

During their period of power the Republicans had held that federal authority should be extended. When the Democrats gained office in 1933, instead of reversing this policy, President Franklin D. Roosevelt's New Deal policies broadened federal control far beyond earlier limits. The Republicans then maintained that many powers of the states were being usurped by the Federal government. After the second World War, most of the members of both parties agreed to a bipartisan foreign policy.

Following Dewey's defeat in 1948 Senator Robert Taft of Ohio became the spokesman for the Republican party. In 1952 Taft campaigned vigorously for his party's presidential nomination but lost to Dwight D. Eisenhower, former general of the Army.

To oppose the popular war hero the Democrats nominated Adlai E. Stevenson, governor of Illinois. Stevenson was an able and respected candidate but the American people decided that it was "time for a change" in political parties. Eisenhower was overwhelmingly elected president, heading the first Republican administration in 20 years.

Third Party Movements

In an effort to deal directly with current issues, voters have occasionally formed minor, or third, parties (*see* table on following page). But a third party has usually proved futile in American politics. Both major parties work against it, for any success would draw support from their membership. And if a third-party platform has great popular appeal, it is usually adopted by one or both of the major parties.

The first distinctive third party that appeared was the Anti-Mason. The Nullification and Anti-Jackson parties were South Carolina protests against federal authority. The American, or Know Nothing, party in 1856 opposed foreign immigration and Roman Catholics. Their nickname came from the reply "I know nothing," when asked what their party represented.

The Liberty and Free Soil parties were antislavery groups organized before the Civil War. A faction that avoided the slavery issue was the Constitutional Union party of 1860.

The Greenbacks of 1876 and the Populists, or People's, party in 1890 advocated cheap money. In 1920

NOMINATING A REPUBLICAN CANDIDATE FOR PRESIDENT

Here a speaker addresses a Republican national convention. A majority vote of the delegates is necessary to nominate the party's candidate for president. At the upper right are radio and television facilities that communicate the proceedings to millions of voters.

the Farmer-Labor party entered national politics. Several socialist and communist parties have come into existence (*see* Labor Parties; Socialism). The Prohibition party has been active since 1869.

In 1912 the Progressive party, led by Theodore Roosevelt, split the Republican vote and helped elect Woodrow Wilson, a Democrat. In 1924 it presented a national ticket headed by Robert M. La Follette, Sr. A new Progressive party was launched in 1948 with Henry A. Wallace as its presidential candidate. It called for a conciliatory attitude toward Russia, a limited form of world government, and the nationalization of basic industries.

THIRD PARTIES THAT WON ELECTORAL VOTES

Year	Party	Candidate	Electoral Vote
1832	Anti-Mason	William Wirt	7
	Nullification	John Floyd	11
1836	Anti-Jackson	W. P. Mangum	11
1856	American (Know Nothing)	Millard Fillmore	8
1860	Democrat (Secessionist)	J. C. Breckenridge	72
	Constitutional Union	John Bell	39
1892	People's (Populist)	James B. Weaver	22
1912	Progressive	Theodore Roosevelt	88
1924	Progressive	Robert M. La Follette, Sr.	13
1948	States' Rights	J. Strom Thurmond	39

Another third party that arose in 1948 was the States' Rights, or "Dixiecrat," group. It drew its support from Southern Democrats enraged at President Truman's civil-rights proposals.

Political Parties in Canada and Abroad

Since its confederation in 1867 Canada has had two major factions striving for political power—the Liberal party and the Liberal-Conservative group, renamed the Progressive Conservatives in 1942. Most influential of the third parties has been the Co-operative Commonwealth Federation (C.C.F.), formed in 1932 (*see* Canadian History).

In England political parties began with the Whigs and Tories in the days of Charles II. Opposing factions were called odious names: "whiggamore," the Scottish word for horse thief, and "tory," an Irish outlaw. The Whigs held that the king was only an officer of the government; the Tories supported the absolute power of the king.

Following the Reform Bill of 1832, the Whigs changed their name to Liberals, and the Tories became the Conservatives. After the first World War, the Liberals gradually lost to the Labor party their position as chief opposition to the Conservatives (*see* English History).

In other European countries there are usually many parties, sometimes 10 or 15. In some nations there are parties representing social classes—capitalists, agrarians, and laborers. There are also religious and secular parties; monarchic and dictatorial parties; democratic, socialistic, and communist parties; and parties of submerged nationalities.

Following the practice introduced during the French Revolution, they are classified as Right, Center, and Left according to their seating arrangement in the council chamber. On the Right are the monarchic and conservative groups, and often the clerical party; in the Center are the agrarians, liberals, and other democratic factions; and on the Left are the radicals, including extreme socialists and communists.

Totalitarian governments usually permit only one, state-controlled party. All other groups which might oppose government policies are outlawed.

POLITICAL SCIENCE—*The* STUDY *of* GOVERNMENT

POLITICAL SCIENCE. The branch of the social sciences dealing with the state and the individual's relation to the state is called political science. It is concerned with the theories of government in general as well as the practical institutions, laws, and duties of citizenship. Political science is commonly studied in the schools under the name of *civics* (*see* Citizenship; Government).

Every government is built on the foundations of an earlier one. Even when revolution seems to sweep away all of an older regime, much of the old still remains. The harsh dictatorship of Soviet Russia, for example, reflects the autocracy that the Communists overthrew. Governments are often spoken of as "social experiments," and political scientists try to extract from them rules for future guidance. So far in the world's history, however, there has been little opportunity for men to build national governments based upon rules derived in this fashion.

Philosophical ideas and social ethics do affect the principles of every government nevertheless, and a rich literature treating these concepts has grown up. Aristotle founded political science with his teachings about the state and its relations to its citizens. His views continued to exercise influence through the Middle Ages. In the Renaissance, the Italian statesman Niccolò Machiavelli broke with classical tradition and developed principles of modern "practical politics." In the 17th century Thomas Hobbes and John Locke (who influenced American colonial thinking) wrote on political science as a part of their systems of philosophy. The Baron de Montesquieu related political development to its physical surroundings, while Jean Jacques Rousseau and Immanuel Kant developed theories of the state that gave men the greatest possible freedom. Others who influenced men's thoughts on government were the Comte de Tocqueville, Walter Bagehot, and John Stuart Mill. In recent times economic theory has had a strong effect upon government. The Soviet state was based on the theories of Karl Marx. This influence has been extended far beyond Russia. In England and the United States the economic teachings of John Maynard Keynes have exerted influence.

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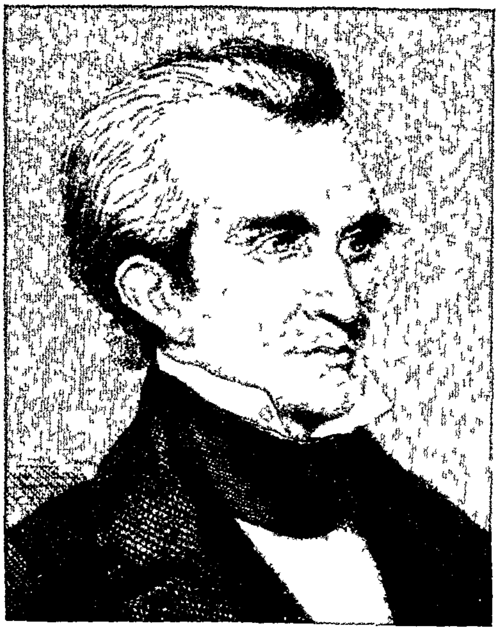
The PRESIDENT *Who Won the* PACIFIC STATES

POLK, JAMES KNOX (1795–1849). The same Scotch-Irish stock which produced Andrew Jackson, the seventh president of the United States, produced also James K. Polk, the eleventh president. Polk grew up under much the same frontier conditions as had Jackson, and he was devoted to the principles of "Jacksonian democracy." Like Jackson again, he desired to expand United States territory—a policy which resulted in bringing both Texas and the Oregon territory into the Union during his administration.


JAMES KNOX POLK

His Early Career

Polk's ancestors (then called Pollock) had emigrated from northern Ireland to America early in the 18th century, and his father had been a soldier in the American Revolution The boy James was born amid primitive farming conditions in Mecklenburg County, N. C., and obtained such education as that frontier district permitted. He entered the University of North Carolina, at Chapel Hill, at the age of 20; and when he was graduated, in 1818, he was acknowledged to be the best student in his class in mathematics and the classics, and for this reason was chosen to deliver the Latin salutatory address. Two years later he was admitted to the bar and practiced law at Columbia, Tenn.

Polk's ability as an orator was called into use in the political field as well as the legal field. He was in great demand at political meetings, and he soon earned the title of "Napoleon of the Stump." During his period of study for the bar he had made the acquaintance of Gen. Andrew Jackson, and his friendship undoubtedly influenced his ideas as well as advanced his fortunes.

Polk's political career began in 1823, when he was chosen a member of the Tennessee legislature. Before his election to the presidency, 21 years later, he had successfully filled the positions of state legislator, had been a representative in Congress for 14 years, filling for four years the difficult post of Speaker of the House when partisan feeling was exceptionally bitter, and had served two years as governor of Tennessee (1839–40). He was recognized as an able Jacksonian Democrat, and was discussed for the vice-presidency in 1840; but in spite of Jackson's influence in his behalf he was defeated for re-election as governor in 1841 and again in 1843

In national politics Polk believed that the government had no right to charter a national bank, or to collect more money from the tariff than was needed to pay the expenses of the government; and he

declared that anti-slavery agitation was a positive evil. Nevertheless, as presiding officer of the House of Representatives, he was fair to those who differed with him. Even the critical John Quincy Adams, the anti-slavery leader of the House, declared that Speaker Polk rendered him "every kindness and courtesy imaginable" during political debates.

It was not on these questions, important though they were, that Polk was elected president, but on that of the expansion of territory. It was understood, before the Democratic National Convention met at Baltimore in 1844, that Polk was a candidate for the nomination for vice-president. Shortly before the Convention met, ex-President Van Buren issued a statement opposing the annexation of Texas. This lost him the nomination and gave it to Polk, with whom was nominated George M. Dallas of Pennsylvania for vice-president. Polk's platform was summed up as the "Reannexation of Texas and Reoccupation of Oregon," and his determination to thus extend the boundaries both on the southwest and on the northwest brought him the election. The popular campaign cry, especially in the North, was "Fifty-four forty or fight"—thus expressing the determination to take the whole of the Oregon country up to the border of Russian Alaska (54° 40′ north latitude) in spite of the counter claims of Great Britain. Polk and Dallas received 170 electoral votes to 105 cast for Clay and Frelinghuysen, the Whig candidates.

POLK'S ADMINISTRATION
1845–1849

Texas admitted (1845) as a Slave State; Iowa (1846) and Wisconsin (1848) as Free States.
War with Mexico (1846-48).
Wilmot Proviso defeated (1846)
Northwest Boundary Question settled by Treaty with Great Britain (1846)
Low Tariff Act passed (1846).
Sewing Machine patented by Elias Howe (1846).
Gold discovered in California (1848).
Territory of Oregon organized without Slavery (1848)
Free Soil Party formed (1848).

The question of the annexation of Texas was practically settled on the last day of Tyler's administration, when a joint resolution was passed by Congress providing for its admission into the Union. But the work of carrying out this resolution fell to President Polk, and its logical result was war with Mexico. This came about through a dispute between Texas and Mexico over the boundary between the two. Texas claimed the Rio Grande River as its boundary, while Mexico insisted that it was the Nueces River. President Polk agreed with Texas and sent General Taylor to occupy the territory which was in dispute.

Polk and the Mexican War

The Mexican government naturally resented this. After a clash between the troops of the two countries in the disputed territory, President Polk asked Congress to declare war, on the ground that "American blood had been shed on American soil." The North was not as a whole enthusiastic over the annexation of Texas, feeling that it meant an extension of slavery; and when President Polk asked for the declaration of war, many Northern congressmen criticized the grounds alleged for war. Lincoln, who was then in Congress, introduced a resolution asking that the president point out the spot of "American territory" on which American blood had been shed. In spite of this criticism, Congress supported the Mexican War, which was carried through to a successful conclusion (*see* Mexican War). The result was to add to the United States not only the disputed territory between the Nueces and Rio Grande rivers, but also California, Utah, Nevada, and parts of Arizona and New Mexico—more than 522,000 square miles of new territory—in return for a payment to Mexico of $15,000,000.

The addition of this territory again raised the slavery question in Congress. David Wilmot of Pennsylvania moved that, inasmuch as slavery did not exist under Mexican rule, it be specified in the appropriation bill that slavery should not be allowed in any of the territory acquired from Mexico. This "Wilmot Proviso" was not passed, but it brought sharply to the fore the question of the extension of slavery into new territories. The discovery of gold in California in 1848 and the subsequent rush of settlers into that region rendered the question an important one; but it was left for the next administration to attempt to solve it by the Compromise of 1850.

The Trouble over Oregon

The Oregon question was settled without resort to arms. Though the Democrats had declared that they were in favor of taking all of the Oregon country, to which both England and the United States could advance reasonable claims, they accepted England's suggestion to divide the territory along the 49th parallel, England taking the part to the north and United States that to the south of this line. This was a continuation of the northern boundary of the Louisiana Purchase to Puget Sound. President Polk disliked to accept the suggestion because of his campaign promises; on the other hand he did not care to become involved in war with England; so he left the decision to the Senate, which agreed to accept England's suggestion.

President Polk was consistent in his attitude towards the tariff, the bank, and internal improvements. Believing that the farmer, as well as the manufacturer, was "entitled to the nation's protection," he supported the tariff of 1846, which reduced duties so that they approached more nearly a "revenue" basis. He vetoed two river-and-harbor bills providing for internal improvements at the expense of the national government; and he supported the Independent Treasury Act, which ordered that national funds should be kept in the national treasury.

In 1848 he refused to run again for the presidency. Polk enjoyed his family circle. He looked forward to the greater leisure he would have upon retirement. But he did not enjoy this pleasure very long. He died on June 15, 1849, only three months after he left the White House.

POLLINATION. The transfer of the fertilizing cells (pollen) from the male stamen to the female pistil of plants is called pollination. There are three natural methods of carrying pollen from one plant to another: by wind, by insects or birds, and by water. The flowers of some plants are able to fertilize themselves; in these, pollination occurs through contact. Men pollinate corn and other plants by hand in order to produce new varieties of seed (*see* Corn). Methods have been developed for fertilizing some seeds with chemicals. (*See also* Flowers.)

POLLOCK. This fish of the cold North Atlantic Ocean is a member of the cod family. It is often called "Boston bluefish." Pollock are handsome green fish, 2 to 3 feet long and weighing 4 to 12 pounds. They live at all levels of the shallow coastal waters from Chesapeake Bay to the Arctic. They form in schools at the surface and, like porpoises, break water as they dive and roll in pursuit of shrimp, herring, and other food.

Most of the catch is landed in New England. The fish are taken in gill nets in the mid-depths and in otter trawls on the bottom. They are marketed as fillets. The scientific name is *Pollachius virens*.

POLO, MARCO (1254–1323?). In 1298 a Venetian adventurer named Marco Polo wrote a fascinating book about his travels in the Far East. Men read his accounts of Oriental riches and became eager to find sea routes to China, Japan, and the East Indies. Even Columbus, nearly 200 years later, often consulted his copy of 'The Book of Ser Marco Polo'.

In Marco's day the book was translated and copied by hand in several languages. After printing was introduced in the 1440's the book was circulated even more widely. Many people thought that the book was a fable or a gross exaggeration. A few learned men believed that Marco wrote truly, however, and they spread Marco's stories of faraway places and unknown peoples. Today geographers agree that Marco's book is amazingly accurate.

Marco Polo was born in the city-republic of Venice in 1254. His father and uncles were merchants who traveled to distant lands to trade. As a boy Marco played along the wharves and canals and in the city's great shipyards. In 1269 Marco's father Nicolo and his uncle Maffeo returned to Venice after being away many years. On a trading expedition they had traveled overland as far as Cathay (China). Kublai Khan, the great Mongol emperor of China, asked them to return with teachers and missionaries for his people. So they set out again in 1271, and this time they took Marco. He was then 17 years old.

From Venice the Polos sailed to Acre (or Akka) in Palestine. There two monks, missionaries to the Chinese, joined them; but these men feared the hard journey that lay ahead and soon turned back. The Polos went on by land. They crossed the deserts of Persia and Afghanistan. They mounted the heights of the Pamirs, the "roof of the world," and descended to the great trading cities of Kashgar (Shufu) and Yarkand. They went on over the dry stretches of the Gobi. Early in 1275, the Polos arrived at Kublai Khan's court at Cambaluc (modern Peking). Marco was now 21.

At the Court of the Great Khan

Marco quickly became a favorite of Kublai Khan. For three years he governed busy Yangchow, a city of more than 250,000 people. He was sent on missions to far places in the empire: to Indo-China, Tibet, Yunnan, and Burma. From these lands Marco brought back stories of the people and their lives.

The Polos became wealthy in Cathay. But they began to fear that jealous men in the court would destroy them when the khan died. They asked permission to return to Venice. This Kublai Khan refused. Then came an envoy from the khan of Persia. He asked Kublai Khan to send a young Mongol princess to be his bride. The Polos pointed out that the princess' journey should be safeguarded by men of experience and rank. They added that the mission would enable them to make the long-desired visit to Venice. The khan reluctantly agreed.

There was danger from robbers and enemies of the khan along the overland trade routes. So a great fleet of ships was built for a journey by sea. In 1292 the fleet sailed, bearing the Polos, the princess, and 600 noblemen of Cathay. They traveled southward along Indo-China and the Malay Peninsula to Sumatra. Here the voyage was delayed many months.

The ships then turned westward and visited Ceylon and India. They touched the East African coast. The voyage was hazardous, and of the 600 noblemen only 18 lived to reach Persia. The Polos and the princess were safe. When the Polos landed in Venice they had been gone 24 years. The precious stones they brought from Cathay amazed all Venice.

Later Marco served as gentleman-captain of a ship. It was captured by forces of the rival trading city of Genoa, and he was thrown into a Genoese prison. There he wrote his book with help from another prisoner. Marco was released by the Genoese in 1299. He returned to Venice and engaged in trade. His name appears in the court records of his time in many lawsuits over property and money. He married and had three daughters. He died about 1323.

POLO. Once polo was played and watched only by wealthy people. Today army and professional teams bring the sport to many thousands. The collision of horse against horse and the strength and agility of horse and man make polo a thrilling sport.

A polo team has four mounted players. Each member carries a light mallet 50 to 56 inches long. It resembles an elongated croquet mallet, but in polo the ball is struck with the side of the head instead of the face. The ball is made of willow root and painted white. It has a diameter of $3\frac{1}{4}$ inches.

A polo field is 300 yards long and 160 yards wide. At the boundaries, vertical boards confine the ball to the playing area. If there are no boards, the width of the field is extended to 200 yards. The goals are placed 25 yards in from the ends of the field. The goal posts are 10 feet high and 24 feet apart. Indoor playing areas vary widely. An indoor team is made up of three players.

The periods of play (called *chukkers*) are 7½ minutes long. Eight chukkers constitute a game. Between chukkers the players change to fresh horses. The object of the game is to drive the ball between the opponents' goal posts. As in basketball and hockey, intricate plays are employed.

Horses and Men

Polo horses were once called "ponies." Today larger horses are used. They are very carefully trained. A team's success depends upon its horses. Tactics of the game often call for a player to check an opponent by blocking the opponent's horse with his own. The contacts are often violent. Polo horses are trained to survive such contacts, to be adept at changing direction and speed, and to have great endurance. The best-trained horses come from Argentina. Superior polo horses have sold for as much as $20,000.

A player's skill is rated by the number of goals he may be expected to make in a single game. The most skilled rating is ten goals. Polo players need not be young men. The highest-rated players are usually in their late 30's and 40's. Men as old as 60 play polo. To adjust the difference between a stronger and a weaker team, the ratings of team members are totaled. The team with the highest total is "handicapped" by the difference between the two totals. For example, if the difference is 2, the weaker team is allowed to add 2 to its score. In international and open tournaments, teams are not handicapped.

The Long History of Polo

Some historians believe that the Persians played polo before the birth of Christ. From Persia the game is thought to have spread to India, Turkestan, Tibet, China, and Japan. The word polo may have come from the Tibetan word *pulu,* a ball. The game is supposed to have flourished in India until the 16th century. Thereafter it was kept alive by the men of Manipur, a Far Eastern state of India. It is thought that English army officers learned the game from the Manipurans. Another theory is that English officers in India invented the game.

Army officers brought the game to England in 1869. The first polo game in the United States was played indoors in 1876. The earliest English teams used eight players. Later the teams were reduced to five, then to four. Polo is a national sport of the Argentine; in Buenos Aires a big game will draw 60,000 spectators. Polo is now one of the Olympic sports (*see* Olympic Games).

American play and rules have served to quicken and popularize polo, and American teams have won many international tournaments. However, the best-balanced teams are produced by the Argentine.

POLO, WATER. A good water-polo player must be able to swim fast, hold his breath for long periods, and have great endurance. The game is played by teams of seven members. The "field" may be either in an indoor pool or in open water. The playing area should be from 19 to 30 yards long and no more than 20 yards wide. Each goal net is set one foot inside the end of the playing area. This net is 10 feet wide and has a crossbar three feet above the water An inflated ball, 27 to 28 inches in circumference, is used. Games are 20 minutes long, divided into equal quarters. Players must not touch the ball with both hands or stand on the bottom. Goalkeepers are exempted from these rules. The ball is propelled by a push or blow of wrist, arm, head, or foot. Water polo was devised in England in the 1870's. It is now one of the Olympic contests (*see* Olympic Games).

A TENSE MOMENT IN POLO

Here is a moment of fast action on the polo field. Texas and California teams are playing. A Texan (wearing a black jersey) reaches far to his right to swing at the polo ball with a lusty forehand drive. A Californian (light jersey) attempts to save the ball from the blow with a backhand stroke. Behind, players of both teams close in.

POMEGRANATE (*pŏm'grăn-ĭt*). Since ancient times, people in tropical and Mediterranean countries have enjoyed the pomegranate for its tart, refreshing flavor. They have also pictured the plant as a symbol of beauty in literature and design. Its large scarlet flowers and its red-gold spherical fruit growing out of the axis of its

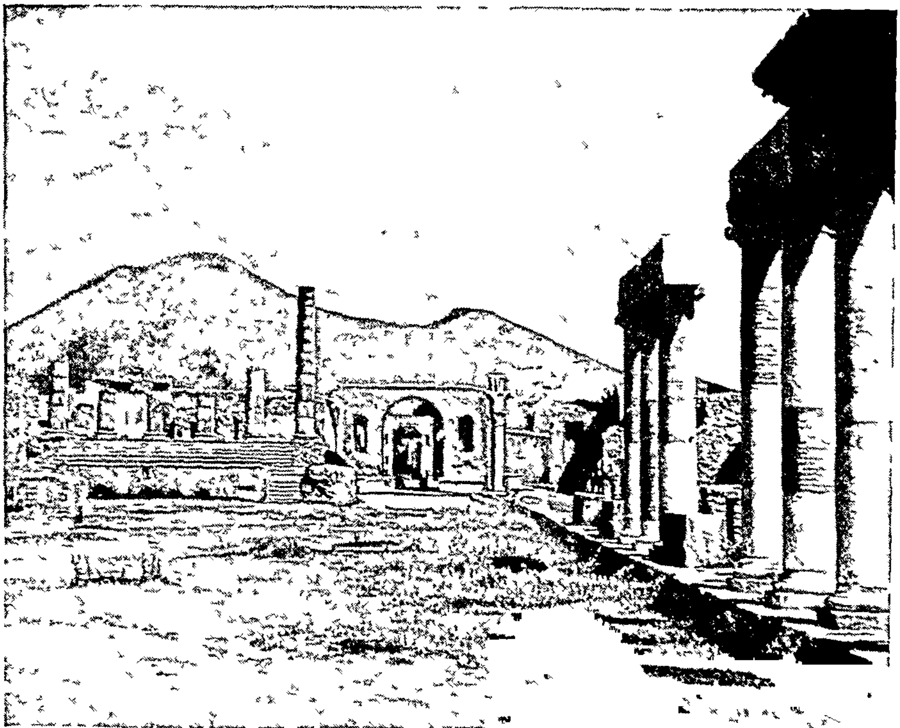
shining green leaves, have inspired countless allusions in literature and representations in ancient sculpture. The Bible contains many references to it, and in the 'Odyssey' the pomegranate is mentioned in the description of the gardens of the mythical kings of Phaeacia. According to the Greek legend Persephone had to spend one third of each year in the underworld, because she had eaten a seed of the pomegranate while living with Pluto. (*See* Demeter.)

The pomegranate is little used today as an article of food, for the palatable pulp is merely a coating for the innumerable seeds. It is still used in Mexico and Iran, however, for making beverages. The leathery rind of the fruit, the bark of the tree, and the root yield tannin for use as an astringent in medicine and in tanning leather.

The pomegranate grows wild in Afghanistan, Pakistan, and southwest of the Caspian Sea and is widely cultivated throughout the tropics and subtropics. In the United States it is cultivated commercially only in a few Southern states but is used as a hedge over a wider latitude. The native tree is small and bushlike, with opposite or alternate lance-shaped leaves. Under cultivation it reaches a height of between 15 and 25 feet.

Scientific name, *Punica granatum* (*Punicus* meaning Carthaginian, because it was imported by the Romans from Carthage) Some botanists ally it to the myrtles, others place it in a separate family *Punicaceae*.

The CITIES *That* VESUVIUS BURIED



In long-buried Pompeii a visitor may walk the streets of a city preserved almost intact from the days of the Roman Empire. Mount Vesuvius, whose cinders buried it, towers behind the city.

POMPEII AND HERCULANEUM, ITALY. The country about the Bay of Naples, called Campania, has always been one of the most beautiful regions in the world. In the days of the Roman Empire its blue skies and magnificent scenery led many wealthy Romans to build villas there. The old and prosperous cities of Pompeii and Herculaneum and the quiet little town of Stabiae were among the many local summer resorts. The region had long been called *felix* (meaning "happy") Campania. Then, on the morning of Aug. 24, A D. 79, these towns were destroyed and great stretches of the countryside were laid waste in one of the most famous disasters of history.

On that morning the great volcano Vesuvius suddenly awoke from centuries of sleep. It began to belch forth a great column of cinders, pumice stones, and ashes. A dense black cloud shot up to an enormous height and overspread the heavens. From Misenum, across the bay, this cloud looked like one of the flat-topped Italian pine trees so common in the region. The cloud blew rapidly southward. It soon enveloped Herculaneum and Pompeii, where the darkness was broken only by strange lightning flashes. Sweeping on, the cloud covered Stabiae and other settlements on the south shore of the bay.

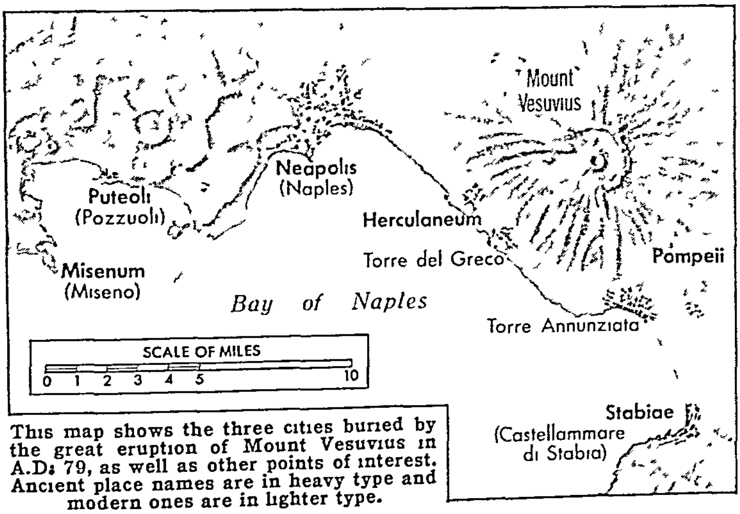
For nearly two days a terrible rain of pumice and ashes fell on the doomed cities and the surrounding country. Most of the population escaped as the eruption began. Others who sought refuge in cellars were suffocated by stifling sulphur fumes or crushed under falling roofs. In Pompeii alone about 2,000 perished. The regular population of this city was probably about 20,000, but it may then have been crowded with summer visitors. The most famous casualty of the great eruption was the elder Pliny. Then in command of the Roman fleet at Misenum, he took ships across the bay in an unsuccessful attempt to rescue refugees. He himself died at Stabiae where he was overcome by poisonous vapors.

When the cloud lifted it revealed widespread devastation. Herculaneum lay completely buried under more than 60 feet of mud and volcanic material. At Pompeii eight to ten feet of pumice and six or seven feet more of ashes covered everything but the tops of the buildings. Farther south the mantle of debris was lighter. So great was the alteration of the seacoast

that Pompeii, which was a seaside town before the eruption, now lies far inland.

The thriving cities of Pompeii and Herculaneum were never rebuilt. In the course of centuries they were forgotten. Then early in the 18th century a well digger turned up a marble statue on the site of Herculaneum. The local government soon after did some excavating and unearthed other valuable art objects. But the deep covering of Herculaneum, which had hardened to rock, made digging difficult and the excavations were abandoned. In 1748 a peasant found traces of the buried Pompeii beneath his vineyard. Since then excavations have gone on, with interruptions, down to the present. In 1926 the Italian government resumed the digging out of Herculaneum, and now large parts of that city are open to view.

SITE OF ANCIENT DISASTER



This map shows the three cities buried by the great eruption of Mount Vesuvius in A.D. 79, as well as other points of interest. Ancient place names are in heavy type and modern ones are in lighter type.

These cities tell the story of Roman everyday life as it is told nowhere else. A visitor may walk between rows of shops and houses, along street after street which still show the marks of the horses' hoofs and the ruts worn by chariot wheels in the paving blocks. He may also read on the walls the scribblings of schoolboys, announcements of shops to rent or gladiatorial contests, and election notices scrawled in flaming red letters.

Public life as shown by the excavations centered in the forum, or market place, where temples elbow business houses and offices. In the market stalls were found charred nuts, fruits, and loaves of bread, left by the dealers in their flight. A wall painting in Pompeii shows how peddlers of kitchen utensils and shoemakers used to ply their trades in the forum itself.

A short distance from the forum of Pompeii is a cluster of temples. With them is a great open-air theater, seating 20,000. Not far away are a smaller roofed theater, the *palaestra*, or athletic school, and the barracks of the gladiators. Here were found gladiators' swords and armor. Three public baths lie convenient to the forum and the palaestra. These are preserved well enough to show how great furnaces were used to heat the water and supply hot-air heat for the rooms and how the bather proceeded from a warming room to a hot room, then to a cold room, and outdoors again.

Home Life in Ancient Roman Cities

The story of private life in ancient Pompeii and Herculaneum is equally complete. The dwellings show a blank wall to the street, as many in southern Europe still do. Once the visitor enters the vestibule he sees that the occupants got their air and sunlight from a central court or a back garden. Opening out of the great room, or *atrium*, are the bedrooms—hardly more than cupboards—the storeroom, dining room, and kitchen. In the kitchen is a raised hearth and on top of this burned the charcoal fire for cooking. In houses where there was a bath this hearth was made to provide heat for that as well. A water system brought water for the bath and sometimes for a fountain in the atrium. Bedrooms off the atrium are tiny cubicles, often furnished with no more than a low wooden bed. At Herculaneum some furniture is still complete, though reduced almost to charcoal. Wall paintings and mosaic floors decorated the homes of the wealthy.

We see also in these cities how people worked as well as how they lived. Outside the bakeries are the great millstones which ground the grain and inside is sometimes found kneading apparatus. A potter's workshop has two ovens; the dyehouses are provided with large lead kettles, and in a closet were found bottles containing colors. A tannery has vats and tools of bronze and iron. There are inns and wineshops, with utensils for heating food and drink and great stone jars set in the counter for storing them.

Many thousands of smaller objects found in Pompeii and Herculaneum have been taken to the museum at Naples for safekeeping. In the museum, there may be seen paintings, statues, mirrors, coins, pens and ink bottles, and even the very food that some Pompeians were having for lunch on the day of the eruption, as well as the pans it was cooked in. In a smaller museum at Pompeii are death casts of some of the people themselves, for the ash that buried them formed a sort of plaster mold which has preserved the outlines of their bodies. One of the most interesting casts from Pompeii is that of a watchdog. The poor creature was apparently forgotten and left behind as his master fled from the city. The dog was found still tied at his customary place in the entrance hall of the house.

The art treasures unearthed at Herculaneum—statues in marble and bronze and paintings—are far more valuable than those from Pompeii. At Pompeii, the covering of volcanic material was much lighter than at Herculaneum. Therefore the owners of houses were able to return and dig out many of their most valuable possessions. In some cases even the marble facing

of buildings has been stripped off. Herculaneum, however, was so deeply covered that no attempt seems to have been made in ancient times to recover anything of value. The most remarkable discovery at Herculaneum was that of 1,800 rolls of papyrus manuscript. They were badly charred, but hundreds have been unrolled and deciphered.

POM'PEY THE GREAT (106–48 B.C.). In the stormy times that marked the close of the Roman republic, Gnaeus Pompeius was one of Rome's celebrated military leaders. He was born in the same year as the famous orator Cicero and four years before the great Julius Caesar. In the civil war between Marius and Sulla he won such a brilliant victory over the Marian armies, in Africa and Sicily, that on his return to Rome he received the title *Magnus*, or "The Great." After a successful campaign in Spain he was elected consul for the year 70 B.C., and although he was under the legal age, and had held none of the lower offices, the Senate reluctantly removed these disabilities by a special act. He espoused the people's cause, and repealed many of the hated laws of the aristocrat Sulla, passed after his victory over the followers of Marius.

After the close of Pompey's consulship he was given supreme command in the Mediterranean and for 50 miles back from its shores—an unheard-of power. He rid the Mediterranean of the pirates who had long infested it; he subdued Mithradates, ruler of the kingdom of Pontus on the shores of the Black Sea, and Tigranes, king of Armenia; and captured Jerusalem and made Syria a Roman province. When he returned to Rome for his third and most splendid "triumph," he was looked upon as a second Alexander.

This triumph marked the turning point in his career, for in political affairs he proved less able than in military. An alliance, known as the first triumvirate, was formed between Pompey, Crassus, and Julius Caesar, and Caesar gave his daughter Julia in marriage to Pompey. But after her death, and that of Crassus, the bond between Caesar and Pompey was loosened, and jealousies arose. While Caesar was ruling the province of Gaul as proconsul and gaining great prestige, Pompey remained at Rome, where he gradually lost influence.

Fearful of Caesar's power, he now returned to the Senate party. The inevitable conflict came when Caesar, refusing to disband his army at the command of the Senate, crossed the Rubicon and marched to Rome. This civil war ended with a complete victory for Caesar at the battle of Pharsalus, in Thessaly, in 48 B.C. Pompey fled to Egypt, where he was treacherously murdered.

PONCE DE LEÓN (*pôn'thā thā lā-ôn'*, English *pŏns'dē lē'ŭn*), JUAN (1460?–1521). The Spanish soldier and explorer Ponce de León is perhaps remembered best because he sought the fabled Fountain of Youth. Born at San Tervás de Campos in León, he fought in the conquest of Granada, and then accompanied Columbus on his second voyage to America in 1493. He established a settlement on Puerto Rico in 1508 and was made governor in 1509. Indians told him of an island called Bimini, the site of a spring whose waters restored youth to all who bathed there. It is said he was seeking this spring when he discovered Florida.

He sailed from Puerto Rico in March 1513. On April 2, shortly after Easter (*Pascua Florida*), he sighted the coast which he named *La Florida*. The next day he landed near the present site of St. Augustine. He then sailed around the peninsula, up the west coast to the vicinity of Charlotte Harbor, and back to Puerto Rico. He returned to Florida in 1521. There he was wounded by Indians and was taken to Cuba, where he died. Ponce de León is buried in the cathedral at San Juan, Puerto Rico. (*See also* Florida.)

POOR RELIEF. No society is so simple that it does not contain some members unable to take care of themselves; and no society is so hard-hearted that it is unwilling to take care of some of its dependents. Orphans, the aged, the blind, the crippled, the feebleminded, and the insane have always been dependent upon others. Athens supported at state expense those who had been wounded in battle and the widows and orphans of those who had fallen. In ancient Rome, Gaius Gracchus introduced the free distribution of grain to the poor classes, and under the Empire some 200,000 were thus fed by the state.

Christianity laid great stress on alms-giving as a religious duty. In the Middle Ages, the Church was the great receiver and dispenser of alms. In England, after the revenues of the Church had been diminished by the Reformation, the state began to take over responsibility for poor relief. In 1601 the Elizabethan Poor Law provided that each parish should collect a tax for relief of the destitute. This system remained in force until 1834, when a new law provided for national control.

At first there was no distinction among types of sufferers needing care. Thus a medieval poorhouse or church refuge contained all kinds of unfortunates lumped together. Today we have special agencies to take care of each type of misfortune in the proper way; and we limit our "poor relief" to those who are unable at the time to make a living, though they are not physically or mentally handicapped.

For the poor we have three kinds of care: private charity, social insurance, and poor relief. Private charities are limited by the amount of money they receive and by the fact that in times of depression, when needs are greatest, contributions drop sharply. Social insurance is possible only where the future cost can be predicted, as for sickness, old age, and temporary unemployment (*see* Social Security). Poverty from other causes must be cared for by some form of poor relief.

For many years, relief in the United States was solely a local responsibility. Counties, townships, and the larger cities cared for their needy under widely varying state laws. This aid was chiefly "in" relief—that is, food and lodging in poorhouses and other institutions. Some "out," or "home," relief—allowances to persons living at home—was given;

but this was done largely by private charitable societies. The success of community campaigns in the first World War led most large cities in 1918 to form "Community Chests" for their chief charitable groups. Each year the charities organize a coöperative, city-wide drive for funds, which they share.

In the national depression of 1930–1941 so many people needed aid that many states enacted home relief programs in 1931. In 1933 the Federal government established a national program for both home and work relief (*see* Roosevelt, Franklin D.). Work relief consists of payment for labor on public projects, such as roads and parks. It costs more than home relief, but is defended on the basis that it improves communities and upholds the morale of workers. In 1935 the government returned home relief to states and later limited its other relief to grants to states for unemployables, such as the blind. (*See also* Foundations and Charities; Pensions; Social Security.)

Pope, Alexander (1688–1744). Few men have triumphed over greater handicaps than did Pope, who became the foremost poet of his day. He was sickly and had a deformed spine; and the intolerance of that day closed the better schools to him because he was a Roman Catholic. But from his earliest youth, according to his own words, verse came to him with little effort. He said that as a child he "lisped in numbers for the numbers came." The "numbers" took the form of the heroic couplet, which was then the prevailing verse form. The following is an example:

Know then thyself, presume not God to scan;
The proper study of mankind is man.

The first long poem which Pope published was the 'Essay on Criticism'. In it he expressed the commonsense ideas of his time on art in literature, in the most compact and highly polished form yet seen in English. The 'Essay on Criticism' made a name for him in 1711, the year of its publication. In 1712 appeared 'The Rape of the Lock', which tells in mock heroic style of the theft of a lock of hair from a belle of his own day. Pope added sarcasm to his verse in such lines as:

Not louder shrieks to pitying Heav'n are cast,
When husbands or when lap-dogs breathe their last.

By this time Pope was famous. He was known to all literary men of London and formed friendships with many of them. Swift the satirist and Lord Bolingbroke the statesman were his favorites. During the ten years following he was busy with his translation of Homer into English verse; this is still the most popular and most generally read translation, though its style, in the words of Matthew Arnold, is "entirely alien to the plain naturalness of Homer's manner."

Crooked and dwarfed in body, Pope was also crooked and dwarfed in spirit. In 'The Dunciad' he heaped ridicule and abuse upon his enemies and critics in a manner rather extreme for modern taste. He excused himself on the plea that less vigor would have no effect. In his own words he says:

You think this cruel? Take it for a rule,
No creature smarts so little as a fool.

All Pope's work shows his mastery of epigram, of tightly packed wisdom. His 'Essay on Man' is more quoted than any other, partly because quotable couplets occur in greater profusion in it. It is also the best expression of the philosophy of life which prevailed so widely in Pope's day: "Whatever is, is right." Today many rank Pope as a great poet. Among others he is assured recognition for his ability to state thoughts in a form half poetic, half philosophic which makes them easy to remember and to quote.

Pope's chief works are: 'Essay on Criticism' (1711); 'Rape of the Lock' (1712); translations of the 'Iliad' and the 'Odyssey', 'The Dunciad' (1728); 'Essay on Man' (1734).

THE TREMBLING POPLAR OR "QUAKING ASP"

All varieties of poplar grow very rapidly, and are valuable for shade and ornament years before the slower-growing hardwood trees have become useful. Here we see the bark, leaves, and "catkins" of the trembling poplar.

Poplar. There are about 25 species of this tree native to the Northern Hemisphere, about half

of them belonging to North America. The genus *Populus* includes the native aspens and cottonwoods. The wood is soft and only aspen has any commercial value. The trees are fast-growing and are often planted on lawns and along streets where quick results are desired. Their shallow, wide-spreading roots, however, obstruct sewers. In the spring the cotton-tufted seeds and fallen catkins accumulate in unsightly masses, clogging gutters and sewer openings. Some communities remove them after more desirable but slower-growing trees become established.

Cottonwood, also called balsam poplar and balm of Gilead (*Populus tacamahaca*), grows throughout Canada and in the extreme northern United States and on the Western plains. In the West these trees grow along stream banks, where in summer their green foliage marks the winding course of the river. They are medium sized, 60 to 80 feet in height, with a trunk diameter of one to two feet. The leaves are three to six inches long and two to four inches wide, pointed, with rounded or heart-shaped base.

The eastern cottonwood (*P. deltoides*) is a larger tree than its Western cousin, averaging 80 to 100 feet in height, with a trunk diameter of three to four feet. The leaves are wider, and the stem of the leaf is flat instead of round, as in the Western species. The most popular ornamental species, native to Europe, is the Lombardy poplar (*P. nigra*), a tall, spire-shaped tree with upward-pointing branches. It bears only male catkins. Hence no seed is possible. The trees are reproduced exclusively by cuttings.

Quaking aspen, or trembling poplar (*P. tremuloides*), is one of the most widely distributed trees in North America. It is fast-growing and short-lived. In areas deforested by fire and logging, it is the first tree to spring up and prepare the way for the other hardwoods and conifers. It has a smooth silvery or cream-colored bark. The trembling of the leaves is caused by the fact that the blade of the leaf is set at right angles to the long, slender, flattened petiole (stem.) The trees are particularly beautiful in the autumn, when their leaves turn bright yellow.

The great tulip tree (*Liriodendron tulipifera*), one of the finest American forest trees, is not a true poplar, though often called "tulip poplar."

POPPY. In midsummer the poppy adds a gorgeous splash of color to our gardens. Tall and stately, with brilliant petals of silken texture, it is one of the loveliest of blossoms. In addition to the single kinds —ranging in color from white, pink, and rose to yellow, orange, and scarlet—there are double varieties, some with fringed petals.

These garden varieties of the poppy have all been obtained by selection and cross-breeding from different wild species, of which the chief are the Oriental poppy (*Papaver orientale*) and the opium poppy (*Papaver somniferum*). The latter has been extensively cultivated to produce the opium of commerce (*see* Opium). Its seeds have no narcotic properties. They yield an oil used in paints and in cheap salad oils.

The common scarlet, or corn, poppy (*Papaver rhoeas*) grows wild in the wheat fields of Great Britain and continental Europe. This is the poppy so often mentioned in English literature. Dr. John McCrae, Canadian poet, made the red poppy a symbol of the first World War when he wrote:

> In Flanders fields the poppies blow
> Between the crosses, row on row,
> That mark our place; and in the sky
> The larks, still bravely singing, fly
> Scarce heard amid the guns below.
>
> We are the dead. Short days ago
> We lived, felt dawn, saw sunset glow,
> Loved and were loved, and now we lie
> In Flanders fields.

The little yellow poppy which grows wild through Midwest America belongs to a different genus (*Stylophorum*). Of still another genus is the California poppy (*Eschscholtzia californica*) from which Luther Burbank developed cultivated varieties of many shades. (For illustration in color, *see* Flowers.)

COUNTING *the* EARTH'S PEOPLE

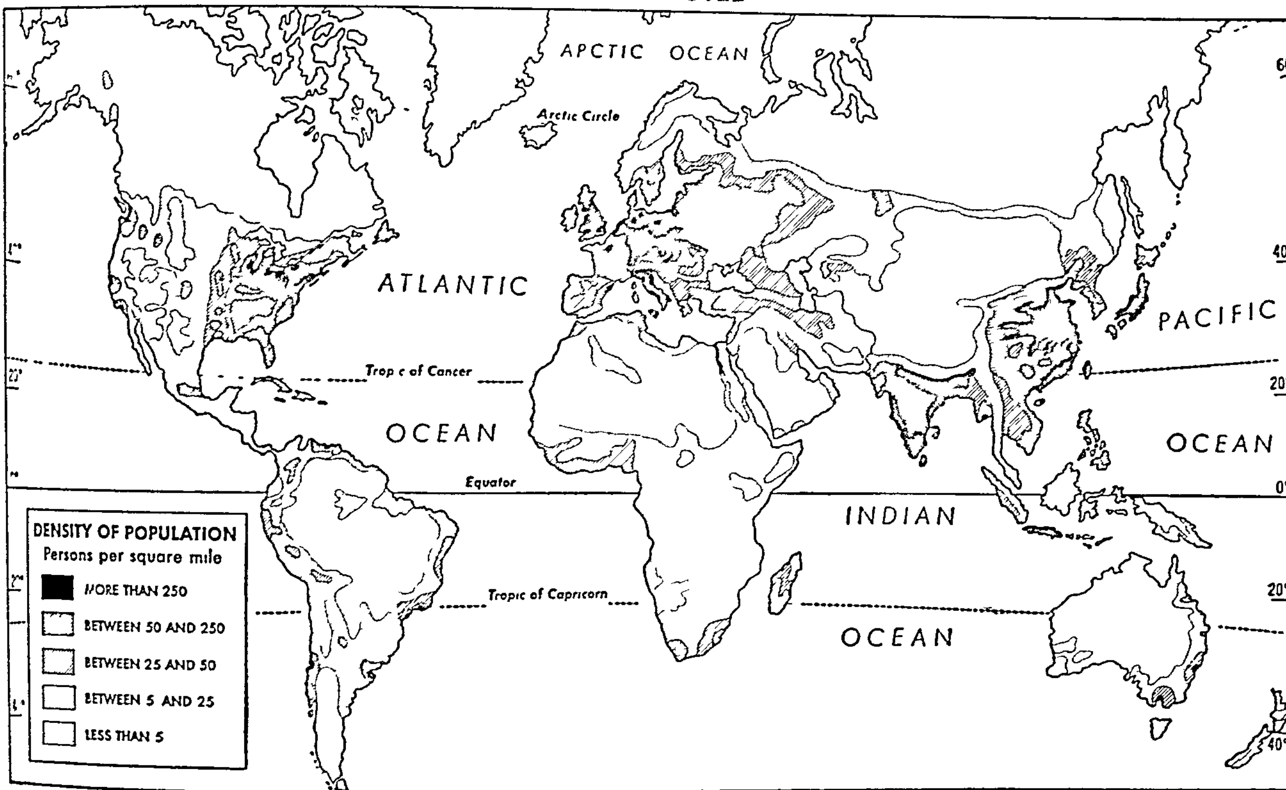
POPULATION. The population of the world has increased more in modern times than in all the other ages of history combined. Until about 1650 the rate of population growth was slow and irregular. At that time there were less than 500 million people in the world, about eight persons for every square mile. Today the world population is about 2,500 million ($2\frac{1}{2}$ billion) and there are more than 46 persons for every square mile. Since 1920 the number of people in the world has been increasing at an average rate of almost one per cent each year. (The article Census tells about the population figures used in Compton's Pictured Encyclopedia.)

The primary cause of this tremendous spurt of population growth is the great advance in science made in modern times. Improved agricultural methods and stock-breeding have greatly increased the world's supply of food. The use of power machines has multiplied the product of man's labor many times (*see* Industrial Revolution). Railroads, steamships, and airplanes have opened up new agricultural and manufacturing regions and have helped provide and distribute the supply of goods, especially food.

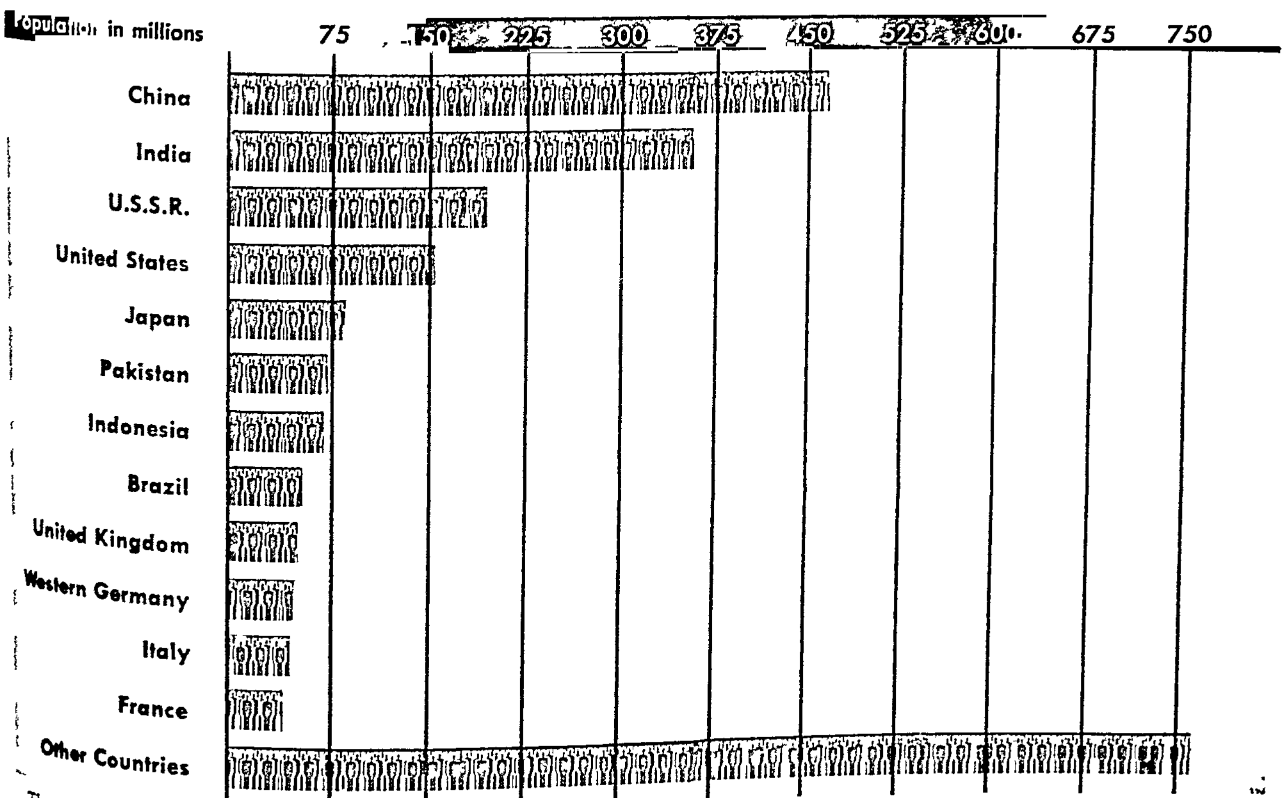
Great strides have been made in medical science and in sanitary facilities. These advances have reduced the death rate by preventing and curing many diseases. The annual death rate in the British Isles, for example, fell in a 50-year period from 23.7 for each thousand of population to 17.5—a decrease of almost one fourth. Thus more people are living to old age than formerly. During the Middle Ages the average length of life was 30 years or less. Today the average in advanced countries is about 70 years and is still rising.

The fastest growing part of the world is Latin America. Here a relatively high birth rate and a

HOW THE POPULATION OF THE WORLD IS DISTRIBUTED

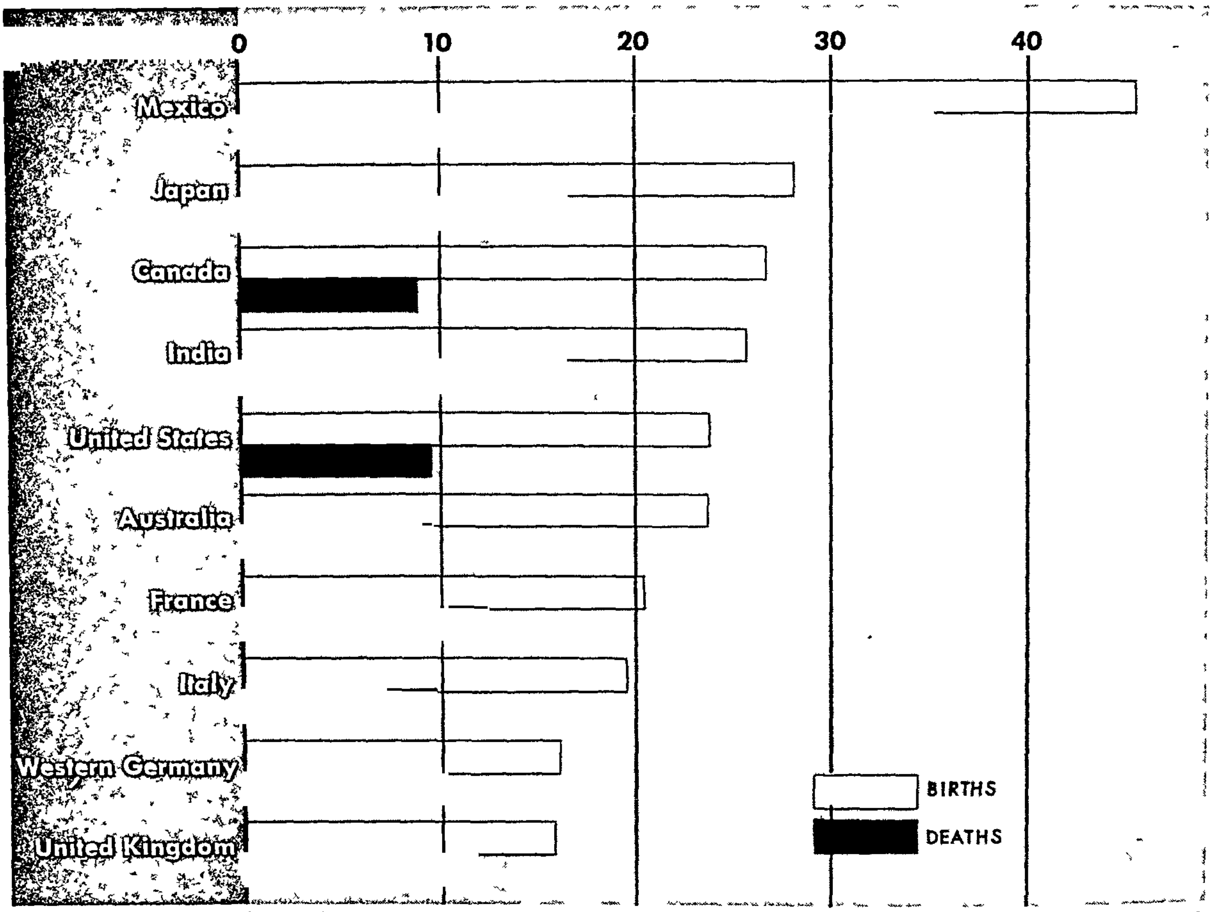


This map shows the density of population throughout the world. The heavily populated parts of Asia and the Nile region have exceptionally rich resources for agriculture. Central Europe, Great Britain, and the metropolitan areas of the Americas have unusual advantages for manufacturing and trade. Arctic, jungle, and desert lands contain few or no permanent settlements.



The population of the world in 1950 was estimated at 2,400,000,000. More than two thirds of the people were concentrated in the 12 largest countries shown here. All population figures are United Nations estimates for 1950 except that of the U.S.S.R., which is a 1946 estimate. The figure for China represents Greater China (18 central provinces plus outlying areas).

How Birth and Death Rates Compare



This graph shows the birth and death rates of every 1,000 people in ten representative countries. If migration is discounted, a nation's rate of growth can be determined by its excess of births over deaths. In Mexico, for example, although the birth rate is high, the rate of growth is slowed by a relatively high death rate. (Data from the United Nations.)

sharp reduction in the death rate have combined to produce a population increase of more than 2 per cent a year. Other rapidly growing regions are Ceylon, Malaya, and Israel.

In many countries, however, population growth has been slowing down. This is particularly true in western Europe. The chief factor in this decline in growth is a decrease in the number of births for each thousand of population. This fall in the birth rate occurs partly because of social and economic conditions. City life, for example, makes it difficult for families with many children to provide the high standard of living expected in the more progressive nations.

Population Trends in the United States

Before the Civil War the population of the United States increased by about one third every ten years. Between 1860 and 1940 the trend was toward a gradual slowing down of growth caused by a decrease in the birth rate and restricted immigration after 1921 (*see* Immigration; United States, subsection "The American People and Their Achievements"). During the 1930's the population increase was only 7.2 per cent. From 1940 to 1950, however, a great "baby boom" added 19 million to the population, which increased 14.5 per cent. During the 1950's it will increase by another 10 to 15 per cent, according to estimates made by the Bureau of Census.

Much of the increase in the United States population has been due to a steady decline in the death rate. From 1855 to 1950 the number of deaths for every 1,000 of population dropped from 20.6 to 9.6. Meanwhile the birth rate has remained stable. For example, in 1915 the number of births for each thousand of population was 25; in 1950, it was 24.1.

As a result of these factors the United States is gradually becoming a nation of adults, with an increasing proportion of its people in the middle- and upper-age brackets. In 1900 there were 90 people under 20 years of age for every 100 between the ages of 20 and 60. Today there are only about 52 people under 20 years old for every 100 in the older group. Since 1820 the average age of the population has risen from 17 to 30 years.

This shift in the age distribution of the population has created new economic problems. The number of productive workers (aged 18 to 65) is increasing at a slower rate than the number of aged people.

This means that the workers may have to bear an increasingly heavier burden of productivity to supply goods and services to the aged. At the same time workers may have to pay relatively more in taxes to supply pensions for the aged who have no jobs and to provide medical care for those who are ill.

In medical science, research may tend to center more on the chronic and degenerative diseases of older people. Two examples are heart disease and cancer. Business faces a new distribution of customers. Those catering to the upper-age groups may expect an increase in trade. The educational system must also meet new challenges. A broad program of adult education would serve to keep older people mentally vigorous by enriching their lives with interests that will make their later years happy and profitable.

In addition to the aging of the population, great shifts in internal migration and settlement have occurred. Today the American people are still moving westward, and California is the fastest growing state in the Union. Another major movement of people is from country to city. The urban population of the United States has grown from 5 out of every 100 in 1790 to 64 per 100 in 1950. The period 1940–50 showed another trend within this urban population—in most of the larger cities the rate of growth was far greater in the suburban communities than within the city itself.

Population by Continents and Races

More than half of all the people in the world live in Asia. Europe, excluding the Soviet Union, has about one sixth of the world's population; North and South America together have less than one third. The most densely populated continent is Europe, which has more than 200 people per square mile. Asia has about 120 per square mile. North America and Russia (European and Asiatic) each have 25.

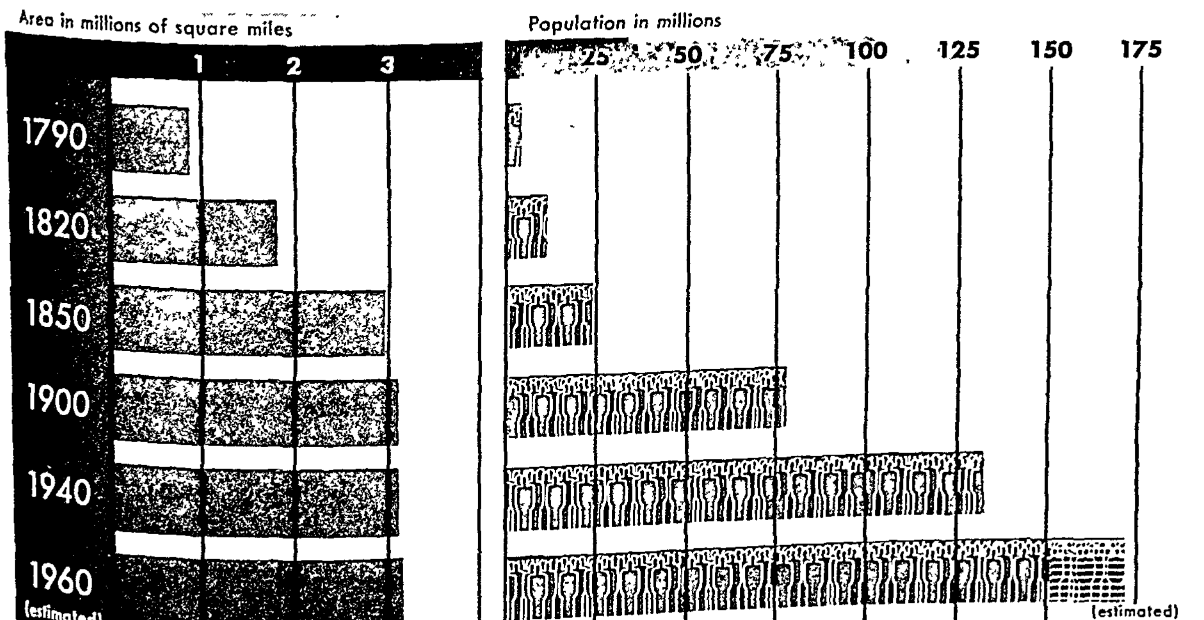
Of the major nations of the world the Netherlands has the greatest number of people, 825, for each square mile. The other leaders are Belgium, with 735; Japan, 575; the United Kingdom, 537; and Western Germany, 502. The average density of population in the United States is 50.7 per square mile.

There are no accurate figures to show the number of people that belong to each of the large racial groups. Authorities estimate that the white race numbers about 850 million and the yellow race more than 700 million. The black and red (Amerinds) races together are estimated at about 200 million, and the brown people at about 500 million. Even these estimates often vary considerably because of the unknown and uncounted millions of mixed stock.

Numbers of Men and Women

Equal numbers of men and women are important to a growing population. Their ratio determines the number of marriages and therefore influences the birth rate. In Europe and the United States accurate birth statistics show that more boys are born than girls. The excess ranges from 20 to 60 more boys per 1,000 births. More boys than girls die in infancy, however, and men are more exposed to death from industrial accidents and war. As a result women live longer than men and tend to outnumber them. Emigration and war have long given Europe more women than men. America and Australia, which received much of Europe's outflowing population, were more masculine countries. The 1950 census, however, showed that the United States now has about 98 men to each 100 women. This

Area and Population Growth of the United States



The graph at the left shows how the nation has grown in size from less than one million square miles to more than 3 million square miles. At the same time the population has increased from about 4 million to more than 150 million. The shaded figures at the end of the bottom row represent the estimated population increase from 1950 to 1960. This is the medium estimate of the Census Bureau. The low estimate is 165 million; the high, 180 million.

excess is in the ages above 40; in the marriagable ages, single men still outnumber single women.

In Asia and Africa a woman's life is harder. Men outlive and usually outnumber the women. For the world as a whole, men are in the majority, the white race being the only one in which women predominate.

It is difficult to predict the future growth of world population. This is particularly true in regard to two of the four major population regions—eastern China and the Indian peninsula. (The other two major regions are central Europe and the metropolitan centers of the Americas.) Asia's two centers of population are on the brink of still greater increase—provided they can reduce the present high death rate. Modern medical science can help, but only a tremendous development of resources can protect such population increases from poverty and famine. (The article World tells of the factors that control the distribution of world population.)

How Many People Can Read and Write?

Statistics on literacy are not strictly comparable among the nations of the world. Sometimes literacy is defined as ability to read, sometimes as ability to write, and often as ability to read and write a simple message. Another varying factor is the age at which literacy is tested. Some nations apply literacy tests to those aged five years or more; others compute figures only for those aged 15 or more.

More than half the people of the world are considered to be *illiterate*. In general, illiteracy is highest in the countries with poor communication facilities. A United Nations study in 1951 showed that Africa, with 83 per cent, has the highest illiteracy rate of all the continents. The other percentages are Asia, with 67 per cent; South America, 50; North America, 20; Europe, 16; and Oceania, 13.

In the United States illiteracy has steadily declined. In 1870, 20 per cent of the nation's people were illiterate; in 1920, 6 per cent; in 1947, 2.7 per cent. These figures are computed for persons aged 14 or more. (The 1950 Census of Population did not test literacy, but "educational attainment.") Illiteracy is about one per cent in Denmark, Norway, Sweden, England, Scotland, Switzerland, Finland, and the Netherlands. Australia, Belgium, Canada, France, and New Zealand have less than 6 per cent illiteracy. The countries with the highest percentages, more than 85 per cent, are Indonesia, Egypt, India, Pakistan, and South Africa.

PORCUPINE. A large and sluggish rodent, the porcupine is noted for its armor of quills, or spines. These protective devices usually lie back on its body but are raised in time of danger.

The best-known American species, the Canada porcupine (*Erethizon dorsatum*), measures three feet, including its short tail, and may weigh from 15 to 30 pounds. Its quills, yellowish-white tipped with black, are two to seven inches long. They grow among the softer hairs and consist of a pith-filled shaft with a hard point. At birth, they are fine and silky and do not thicken into quills for several weeks.

READY TO EAT A FAVORITE FOOD

A flashlight photograph surprises a porcupine high in a treetop where it has climbed to get its midnight meal. Porcupines kill many trees by eating the soft inner bark.

The Canada porcupine lives in the forests of Canada and the northeastern United States. It may roam at any hour, but usually sleeps in hollow logs or among rocks by day and plods forth to feed by night.

With long sharp claws, it draws its stout body up a tree and sits on a limb to gnaw the bark or devour tender twigs. It likes to rake the limb with its claws and cram bark, twigs, leaves, and all into its mouth. To get to its favorite trees, it will swim across rivers and lakes.

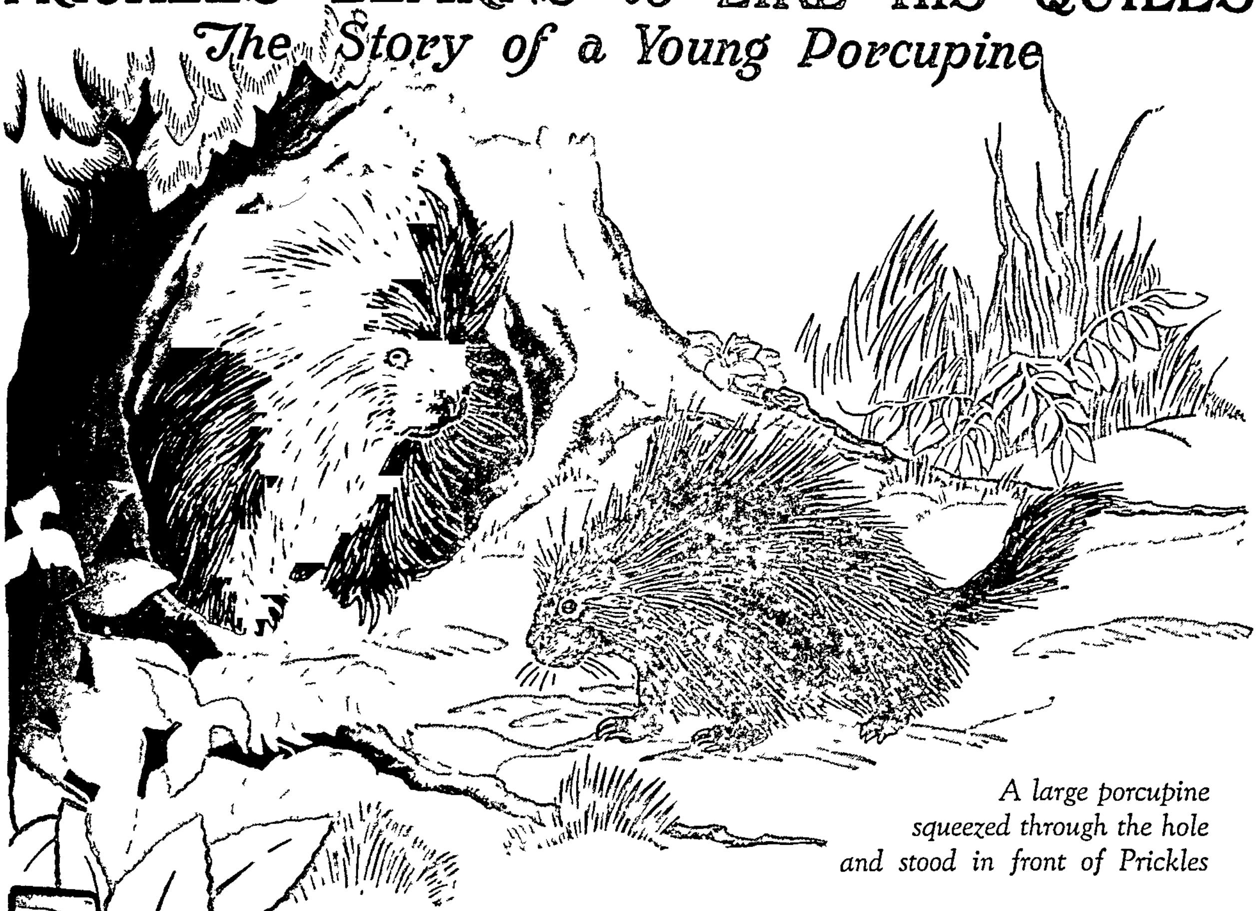
Best of all, the porcupine likes salt. His nose quivering, he waddles boldly into camps to seek out and gnaw any wooden article that has been salted by bacon fat or even by the touch of perspiring hands. The young may follow their parents on these hunts for food. The clumsy babies are born about May 1, one to four in a litter. The flesh of the porcupine was considered a delicacy by the Indians, who also dyed the quills for use in their beadwork.

The tree porcupines, with their long prehensile tails and their short lightweight bodies, live in South America. The porcupines of Europe, Asia, and Africa dig out their homes in the ground. The common porcupine of Europe (*Hystrix cristata*) has quills a foot long.

Contrary to a common belief, the porcupine cannot "shoot" its quills at its opponents. Such stories arise from the fact that the quills are loosely inserted in the skin and become detached at a touch. They make painful wounds, for small barbs at their tips cause them to work deeper and deeper into the flesh of the victims. The porcupine is sometimes called a hedgehog, but this name properly belongs only to the European hedgehog (*see* Hedgehog).

PRICKLES LEARNS *to* LIKE HIS QUILLS

The Story of a Young Porcupine



A large porcupine squeezed through the hole and stood in front of Prickles

PRICKLES, the young porcupine, lived in a little cave by the edge of a wood. He was called Prickles because his back and sides were covered all over with long, prickly quills—white quills with black tips. Even his tail was covered with quills. His head was small and his legs were short and stumpy.

"Oh, dear!" he would often say to himself. "I wish I had nice soft fur like the squirrels. Fur would be much nicer than quills." But he could not change his quills, because all porcupines have them.

Prickles usually slept all day, but this afternoon he was very hungry. So he got up bright and early to look for his breakfast. There was plenty of bark on the trees for him to eat, but he was tired of eating bark. There were plenty of nice juicy twigs, but he was tired of eating twigs, too.

"I wish I could find something new to eat," he thought, "something I have never had before."

All at once he saw a dark hole under the roots of a big tree. "I wonder what is in that hole," thought Prickles. He went a little nearer—something moved inside the hole. He went still nearer—two small eyes looked out at him.

"Oh!" cried Prickles. "Who are you? What is your name? Do you live here?"

The two eyes blinked back at him for a moment and then, very slowly, a large porcupine squeezed through the hole and stood right in front of Prickles.

"You ask a lot of questions," said the porcupine, "but that's all right. You are young and you have many things to learn. My name is Old Quills," he went on politely, "and this is my den. I usually sleep through the day and hunt at night."

"I have a den, too," said Prickles, "but it is smaller than yours. Have you lived here long?"

"I have lived here a long time, little porcupine," answered Old Quills, "for I am very old. I have seen six summers and six winters."

"My!" said Prickles, "you *are* old, aren't you!"

Old Quills shuffled slowly off to look for his breakfast, and left Prickles standing all alone.

"Wait a minute!" cried Prickles. "I want to go with you!" He couldn't walk very fast because his legs were so short, but he walked as fast as he could. A saucy chipmunk scurried past him and called back, "What a slow walker you are, porcupine! Don't you wish you could run as fast as I can?"

Prickles knew he was slow; but he couldn't go faster, no matter how hard he tried. So he just walked on and didn't answer the chipmunk, but his feelings were hurt. Pretty soon he saw Old Quills waiting for him by a hemlock tree.

"Come along, little porcupine," said Old Quills. "I will show you where there are a lot of fine lily pads. They are tender and green and very good to eat."

"Oh, goody!" cried Prickles. "I am so hungry that I could eat them all."

As they shuffled along on their stumpy legs, the little creatures of the woods peeped out from their nests and burrows to look at them.

"See the clumsy porcupines!" said a rabbit. "Did you ever see such awkward creatures in all your life?"

"Shhh!" whispered a squirrel. "They might hear you and stick you full of quills."

"Pooh," laughed the rabbit, "they won't hear me. Porcupines can hardly hear at all. Anyhow, I am too fast for them."

At last Prickles and Old Quills came to a little pond covered with the loveliest lily pads. "Here is our breakfast," said Old Quills, pulling out a lily pad and munching it slowly. "There is enough here for both of us, and more too."

"I am going to eat all I can hold," said Prickles. "My! they look good!"

He grabbed the nearest one in his mouth and ate it greedily. *Mmmm*—it was tenderer and juicier than anything he had ever eaten. He ate another, and then another. How good they were!

Then Prickles saw the biggest lily pad of all. It was round and green and smooth, and he wanted it very much.

"Maybe if I stretch hard, I can reach it," he thought. So he leaned out as far as he could and tried to seize it with his sharp teeth. The big lily pad was just out of his reach. He leaned out a little farther and—splash! he fell right into the water!

Prickles was so frightened that he splashed and kicked with all his might. "Old Quills! Old Quills!" he called, when he finally caught his breath. "Come quick and help me out!"

But Old Quills just stood on the bank and chewed his lily pads.

"Don't be frightened, little porcupine," he said. "Your hollow quills will keep you up and make you float like a piece of wood. We porcupines don't have to swim if we don't want to," he added proudly. "We just float."

Prickles stopped his splashing and kicking and, sure enough, his quills held him up, just as the old porcupine had said!

"What fun it is to float about on the water like this!" thought Prickles. "I like to float," he said aloud, "it is great sport."

"You had better get out of the water now, young porcupine, if you want to come with me," said Old

"Did you ever see such awkward creatures in all your life?" said a rabbit

"I'm going to eat all I can hold," *said Prickles*

Quills. "I am going to my hemlock tree up on the hill."

"Oh, I do want to go with you, Old Quills!" cried Prickles, as he paddled to the shore. "Please wait for me!"

So the old porcupine waited until Prickles had climbed out on the bank.

"Now then," said Old Quills, "let us go!"

"Ha! Ha!" screamed a bluejay, as the two porcupines shuffled clumsily along. "Look at the funny porcupines! *They* can't fly or run. They can't even walk very fast."

"I don't like to be made fun of," little Prickles said to Old Quills. "I know I can't walk fast and I know I look clumsy, but I wish the other creatures wouldn't laugh at me."

"Don't pay any attention to them," said Old Quills, "we porcupines can do some things that they can't do."

"What?" asked Prickles.

"Well, we can float for one thing," said Old Quills.

"Yes, and that's fun; but we can't run like the squirrels and chipmunks," said the little porcupine. "They think we are slow and clumsy."

"We don't have to run," replied Old Quills. "Other creatures run when they smell danger, because they are afraid. We aren't afraid of anything, because we know how to protect ourselves."

"How do we protect ourselves, Old Quills?" cried Prickles eagerly. "Tell me, won't you?"

"It's very simple," the old porcupine said. "Your sharp quills are your weapons. You haven't any quills on your nose, so if a creature tries to harm you, turn your back to it, put your nose between your forepaws, and then thrash about with your tail as hard as you can. If the creature tries to touch you then, he will get his nose stuck full of your sharp needles. That will teach him to leave you alone, because a nose full of your needles hurts. Most creatures have learned not to bother us."

"Oh," said Prickles, "then we *are* as clever as the other forest creatures, aren't we? Is there anything else we can do?"

"Yes," said Old Quills, "there is another thing."

"What is it? What is it?" cried Prickles.

"Well," said Old Quills, "whenever I get sleepy or tired I crawl into the first little hole I see and curl up with my prickly back in the mouth of the hole. I won't be bothered, because if any other creature tries to get into the hole, he gets stuck with my quills."

"Oh," cried Prickles, "I want to try that!"

"You will have to find a hole first," said Old Quills. "*I* am going to my hemlock tree at the top of the hill. There is nothing I like better to eat than bark and twigs, and that hemlock tree has the nicest bark and twigs in the whole forest."

While Old Quills climbed slowly up the hill, Prickles looked around for a hole to sleep in.

"I guess there are no holes in this hill," he thought, after he had looked and looked. "What shall I do? I am so tired and sleepy."

Just then Prickles saw something black a little farther up the hill. "It looks like a fine sleeping hole," he said. "Hurray! There's just room for me." He crawled into it as fast as he could and put his prickly back right up against the opening.

"Now nobody can bother me, or make fun of me," he thought. "I can sleep just as long as I want to."

By and by he was awakened by a noise outside. He couldn't see out, but he knew from the grunting noise that it was a young groundhog.

"What do you mean by lying in my hole!" the groundhog scolded. "The very idea! Come out this minute!" But Prickles lay very, very still. The young groundhog tried to push his way in. Foolish groundhog!

"Oh me! Oh my!" he cried. "What have you done, porcupine! You've stuck me full of quills. My poor nose! My *poor* nose!"

"Oh, I'm sorry, groundhog," said Prickles. "Why weren't you more polite? You should have known better than to push a porcupine around."

"I will surely know better the next time," said the groundhog, as he tried to pull the quills out of his nose. "I will never make fun of a porcupine again as long as I live."

"You may have your hole now," Prickles said. "I've had a good sleep and I must go and find Old Quills. Goodby, I'm sorry I hurt you." The groundhog didn't answer. He was too busy rubbing his sore nose.

Prickles had not gone far before he saw Old Quills coming toward him. "Did you find a hole, little porcupine?" Old Quills asked.

"Yes," said Prickles, "I found a groundhog's hole. He came home and started to push in. When I left him he was busy pulling my quills out of his nose."

"Ho—ho!" chuckled Old Quills. "You are learning fast. All the creatures will soon learn not to make fun of *you*. And now let's go home. You have had an exciting day for a little porcupine, and we have a long walk."

So Prickles and Old Quills started home. Prickles was very happy.

"I would rather be a porcupine than any other creature in the forest," he told Old Quills, as they shuffled along. "Porcupines can do so many, many things."

"You should have known better than to push a porcupine around"

PORPOISE (*pôr′pŏs*). These lively inhabitants of coastal waters are among the smallest members of the cetacean or "whale" order. Ocean voyagers often tell of the large schools of "porpoises" that they saw; but if those schools were sighted when the ship was far from land the animals were probably dolphins and not porpoises (*see* Dolphin). The porpoise lives close to the coast, and often enters harbors and even rivers in search of food. It can be readily distinguished from the dolphin by its blunt snout. The snout of the dolphin is long and sharp, like a flat beak.

The porpoise (genus *Phocaena*) is not a fish. It is a mammal; the mother nurses the young with her milk. Like the whale, the porpoise breathes through a single nostril, the "blow-hole," located on top of the head, which is opened during the animal's frequent trips to the surface. Two black "flippers" or fins serve as forelimbs, and there is an upright triangular fin on the back. The tail is horizontal—to propel the animal in its lunges and dives—not perpendicular like the tails of fishes. The porpoise usually swims in a series of long graceful curves which bring its blowhole to the surface and then expose the back fin as it dips downward. Animals have been clocked at sea traveling at a speed of 35 miles an hour, and they can leap ten feet into the air. They are highly intelligent, ranking close to the chimpanzee in their ability to learn. Captives at the Marine Studios, Marineland, Fla., are trained to obey commands and do entertaining tricks. They apparently grow fond of their trainers.

Porpoises are common on the east and west coasts of the North Atlantic Ocean. Their chief food consists of mackerel and herring. The common, or harbor, porpoise is four to six feet long and is usually black on top and white beneath. Under the skin is a layer of fat, or blubber, about an inch thick. It was once a popular article of diet in Europe, but is now used for the oil of fine quality it yields. The thick hide is sometimes made into soft leather. The bay porpoise of the Pacific coast reaches a length of nearly six feet.

An interesting relative of the porpoise is the narwhal (*Monodon monoceros*). In the male narwhal one of the teeth of the left upper jaw projects forward in a long, spirally twisted ivory tusk, about half the length of the body. The full-grown narwhal is about 20 feet long. Narwhals are found chiefly in the Arctic Ocean.

PORTER, DAVID DIXON (1813–1891). Second only to his foster-brother, Admiral Farragut, in naval achievements during the Civil War was David Dixon Porter. He was the son of Commodore David Porter, who had commanded the famous frigate *Essex* during the War of 1812. As a boy he had had an exciting career. At the age of 12 he sailed with his father in an expedition against the pirates in the West Indies, and when 14 he entered the Mexican navy of which his father was, for a time, commander-in-chief. While in this service he was captured by the Spaniards with whom Mexico was then at war. After his release he entered the United States navy as a midshipman, in 1829, saw service on a paddle-wheel steamer in the Mexican War, and made two trips to the Mediterranean countries to procure camels for army use in the Southwest.

At the outbreak of the Civil War, Porter was promoted to the rank of commander in the navy and during the war he helped to win three important victories. First, when Farragut attacked New Orleans, in April 1862, Porter's fleet of mortar-boats bombarded the forts below the city so fiercely that Farragut was able to pass through in comparative safety and capture the town. Then, with a fleet of gunboats Porter coöperated with Grant in the siege of Vicksburg, guarding the city so closely by water, while Grant cut it off from outside communications by land, that it was forced to surrender on July 4, 1863. Finally, in the attack on Fort Fisher, in 1865, Porter—now a rear-admiral—commanded the fleet which coöperated with the land forces of General Terry, helping to capture that fort, and with it Wilmington, N.C., one of the last Atlantic ports open to the Confederates.

At the close of the war, in 1865, Rear-Admiral Porter was made superintendent of the naval academy at Annapolis. As a final recognition of his services, he was appointed in 1870 to succeed Farragut as an admiral of the United States navy, a rank which was not given to another until 1899, when it was conferred upon Rear-Admiral Dewey for his victory over the Spanish fleet at Manila Bay.

PORTER, WILLIAM SYDNEY ("O. HENRY") (1862–1910). "A man may see so much that he'd be bored to turn his head to look at a $3,000,000 fire or Joe Weber or the Adriatic Sea. But let him herd sheep for a spell and you'll see him splitting his ribs laughing at 'Curfew Shall Not Ring Tonight', or really enjoy himself playing cards with ladies."

When America's most popular short story writer wrote that, he was probably thinking of the sheep-herding days of his own eventful career. As a shy freckled small boy in his native town of Greensboro, N.C., William S. Porter,—who became famous under the name "O. Henry"—was fond of 'The Arabian Nights' and other books, of roaming in the fields by himself, of cartooning his friends, and of spinning for them many exciting yarns. Even in those days he was "different." He once explained with modest pride that his feet were freckled.

After attending a school kept by his aunt, young Porter continued his education only in the "School of Good Books" and in the "University of Hard Knocks." Ill health compelled him to give up clerking in the town drug store and to go to work on a friend's ranch in Texas. There in the Southwest he also tried writing short stories, working in a bank, and making up jokes for the papers. After eloping one moonlight night in a borrowed "buggy" with a charming young schoolgirl, he began experiencing the

ups and downs of a varied journalistic career. For a year he edited a humorous weekly called *The Rolling Stone*, furnishing most of the copy himself. After this he worked for a time on the Houston *Post*.

Then came a bitter experience. He had resigned some time before as teller of the First National Bank of Austin. Now he was called back to answer a charge of embezzlement. The affairs of the bank had been handled so loosely that, long before, Porter had protested that it was impossible to make the books balance; and if he had stood trial he would doubtless have been acquitted. But he impulsively decided that he would start life over again and he went to Central America. Hearing of his wife's illness, he returned to Texas and gave himself up. The fact that he had fled from justice weighed heavily against him and he was sentenced to the penitentiary. After his release in 1901 he went to Pittsburgh, and the following year he settled in New York. Something of his old lightheartedness was gone; it was now that his literary work began in earnest.

He saw deep down into the heart of New York. He observed ordinary men and women from a bench in the park or from a table in the restaurant. Clubman or hobo, policeman or thief, the colonel's lady or Judy O'Grady—to "O. Henry" one is as important as the other. And his settings have a large geographic range. Hence his stories have a wide appeal, for no one feels barred from the world in which his characters move.

A master technician in the art of short-story writing, "O. Henry" is famous for experiments in plot and for the surprise endings which give his stories a particular zest. His influence on other writers both in the United States and abroad has been large.

Collections of "O. Henry's" short stories were published under the following titles. 'Cabbages and Kings' (1904), 'The Four Million' (1906); 'Waifs and Strays' (1906), 'The Trimmed Lamp' (1907); 'Heart of the West' (1907); 'The Gentle Grafter' (1908); 'The Voice of the City' (1908), 'Roads of Destiny' (1909); 'Options' (1909); 'Whirligigs' (1910); 'Strictly Business' (1910); 'Sixes and Sevens' (1911), and 'Rolling Stones' (1912). The story of his life as told in 'The Caliph of Bagdad', by R. H. Davis and A. B. Maurice, is as dramatic as any of his own creations.

OREGON'S *Metropolis, City of* ROSES

The Busy and Beautiful City with Mount Hood in the Distance

PORTLAND, ORE. Air travelers flying to Portland for the first time can see the reasons for the city's importance long before they land at the municipal airport. Spread below their plane is the vast Columbia River basin, with its wealth of farms, fisheries, timber, and waterpower. Portland is the gateway to this mighty realm of some 300,000 square miles—a region larger than the Atlantic States, from Maine to South Carolina, put together.

The key to Portland's commanding position is water transportation. Situated in far northwestern Oregon, the city lies on both sides of the Willamette River, 14 miles southeast of its confluence with the Columbia. A channel 500 feet wide and 35 feet deep, built by the Federal government and the city in 1905–18, enables ocean vessels to reach Portland, 113 miles inland from the Pacific Ocean. Hence Portland is the center for industries of the giant Columbia basin This advantage has made it the chief city of Oregon, with about half the state's manufactures and about a fourth of the state's total population.

Few cities have so beautiful a natural setting With an area of approximately 70 square miles, Portland spreads up the green slopes of the Coast Range foothills. Its terraced residential districts look out over the Willamette Valley fruit ranches to the south, the great Columbia to the north, and the forested Cascade Range on the east. About 60 miles southeast, snow-capped Mount Hood crowns the scene.

Visitors enjoy another unique beauty of Portland—its roses. Nearly every home grows them. Many varieties, including the official bloom called the

Caroline Testout, brighten the more than 2,600 acres of public parks. In Washington Park, cuttings from all over the world are cross-grafted in the International Rose Test Garden. The annual Rose Festival, in the second week of June, has been an official city celebration since 1907.

Nearness to the warm Pacific, with its prevailing westerlies, gives the city the moderation of an oceanic climate. The mean annual temperature is about 53°F. Summer has usually "perfect vacation weather," bright with sun, for only about one-tenth of the annual precipitation of about 42 inches falls between June and September. In winter there is little ice in the rivers, snows are light, and, because the Coast Range partly dries the sea winds, Portland usually has about 16 days a year of heavy fog.

Approximately 30 miles of deep-water frontage makes Portland the first large port north of San Francisco and one of the chief fresh-water ports of the nation. The water-level route through a large part of the Columbia basin provides fine facilities for rail and truck transport.

The city's chief products are lumber and millwork. Within a radius of 150 miles, stand forests estimated to have 335 billion board feet of lumber, about one-fifth of the nation's total reserve. Cattle and grain from the Columbia Plateau supply Portland's meat, leather, and milling industries. Fruits and vegetables from the Willamette Valley and fish from near-by rivers make it a canning center. It also has a number of large woolen and knitting mills. During the second World War shipbuilding soared.

Portland's docks handle more than 11,000,000 tons yearly of incoming and outgoing ocean freight. Nearly all the inbound tonnage is from other American ports on the Pacific, Gulf, and Atlantic. Coastwise vessels bring in such products as petroleum, iron and steel, chemicals, and corn. Nearly all the outbound tonnage, made up of lumber, wheat livestock, and wool, goes to foreign ports in the Far East.

Nearness to ample hydroelectric power gives Portland an immense industrial advantage. Much of this cheap power comes from Bonneville Dam, 42 miles up the Columbia (*see* Columbia River; Dam). Most of the more than one thousand factories use electricity, which helps keep the city's air remarkably clean.

Portland's water supply is brought by gravity from Bull Run Lake, 3,000 feet high on Mount Hood. This melted glacier water is so pure that it is suitable in the manufacture of textiles and needs no distillation for use in electrical equipment. It helps to give Portland a very low death rate.

The city's beauty, climate, and excellent recreational facilities make it a favorite with tourists. Sightseers delight in Peninsula Park, with its thousand or more varieties of roses, and in the view from Council Crest Park (1,107 feet), highest point in the city. In Washington Park is the statue of Sacagawea, the "Bird Woman" who guided the Lewis and Clark Expedition. Mount Tabor Park has Gutzon Borglum's statue of Harvey W. Scott, historian and early editor of Portland's distinguished newspaper, the *Oregonian.* The Portland Symphony Orchestra provides the city with excellent concerts. The Civic Auditorium houses the fine collection of the Oregon Historical Society.

Many of Oregon's institutions of higher education are located here. Among them are the University of Portland, Reed College, Cascade College, Lewis and Clark College, and Northwestern College of Law. Also here are medical and dental colleges of the University of Oregon, art school of Portland Art Museum, Vanport (Junior) College, and Multnomah (Junior) College.

Mount Hood, a glacier-capped and extinct volcano, and the surrounding Mount Hood National Forest are noted for scenery. On the slopes of Mount Hood is a 3-mile aerial tramway, the longest in the world. From Portland a highway around the mountain's shoulders joins the Columbia River Highway to form Mount Hood Loop, a one-day motor trip from the city.

Portland sprang from a Chinook Indian "landing" on the west bank of the Willamette. The site was claimed in 1844 by William Overton and Amos L. Lovejoy. Overton traded his share to Francis W. Pettygrove, a merchant from Portland, Me., who tossed a coin with Lovejoy to determine the name of the planned town. Pettygrove won, and the city was incorporated in 1851. Until late in the 19th century it was a supply center for the gold rushes of California and Alaska and for the army in the Indian wars. In 1905 Portland held the Lewis and Clark Centennial Exposition. The city has the commission form of government. Population (1950 census), 373,628.

PORTSMOUTH, ENGLAND. For more than 400 years Portsmouth has served as England's chief naval base. It is situated on the southwestern part of Portsea Island, which lies between two inlets of the English Channel, about 65 miles southwest of London.

The city is really made up of four distinct sections. Portsmouth proper is a garrison headquarters. Portsea is the naval station, with vast dockyards for building and repairing Britain's mightiest battleships. The other sections of the community are Landport, occupied chiefly by the houses of the dock workers, and Southsea, a residential quarter and seaside resort commanding a view of the Channel of Spithead and of the Isle of Wight.

The national prestige of Portsmouth as a naval base dates from about 1540 when Henry VIII established his Royal Dockyard there. This was not the first mark of royal favor for the city, which even then had been for many years an important naval center. Indeed, the very founder of the city (in the 12th century) was King Richard I, who had personally chosen its site. In the 15th century Edward IV improved its moats and walls to make it one of the strongest citadels of Europe. The dockyards of Henry VIII, though extensive for their time, occupied only about eight acres. They have been enlarged through the centuries until today they cover almost a square mile. In the second World War the Germans bombed Portsmouth heavily, causing great damage. *Population (1951 census, preliminary),* 233,464.

LITTLE PORTUGAL *and Its* GREAT PAST

Extent.—North to south, greatest length, 362 miles; east to west, 140 miles. Area, 34,604 square miles (including Azores and Madeira Islands, 35,796 square miles). Population (1950 census), 8,510,240. Possessions (Cape Verde Islands, Angola, Mozambique, São Tomé, Principe, Guinea, Portuguese India, Macao, Portuguese Timor), about 808,900 square miles.

Natural Features.—Much indented Atlantic coast line forming the west and south boundaries; numerous mountain ranges in the interior separated by river valleys (highest range, Serra da Estrella, 6,532 feet). Rivers: Minho, Douro, Tagus, Guadiana.

Products.—Wheat, corn, rye, oats, barley, beans, potatoes, and other vegetables, figs, lemons, and other fruit, olives and olive oil, grapes and wine; livestock, wool hides; sardines, tunny fish; copper pyrites, coal, lime phosphate, tin, tungsten; cork, textiles, embroidery, lace; porcelain tiles and other pottery.

Cities.—Lisbon (capital, 783,226), Porto (281,406).

(For map of Portugal, *see* Spain.)

PORTUGAL. For about 150 years of its history, Portugal was one of the leading powers of the world. Before and after that time it had to struggle constantly for its very existence. It is one of the smallest countries of Europe. With an area of 34,604 square miles, it is little larger than the state of Maine. Yet, during the 15th and 16th centuries, it discovered and ruled an empire that reached round the world. Then it fell under Spanish rule for half a century and lost most of its colonies. After it regained its independence it had to rely for its security on the protection of more powerful allies.

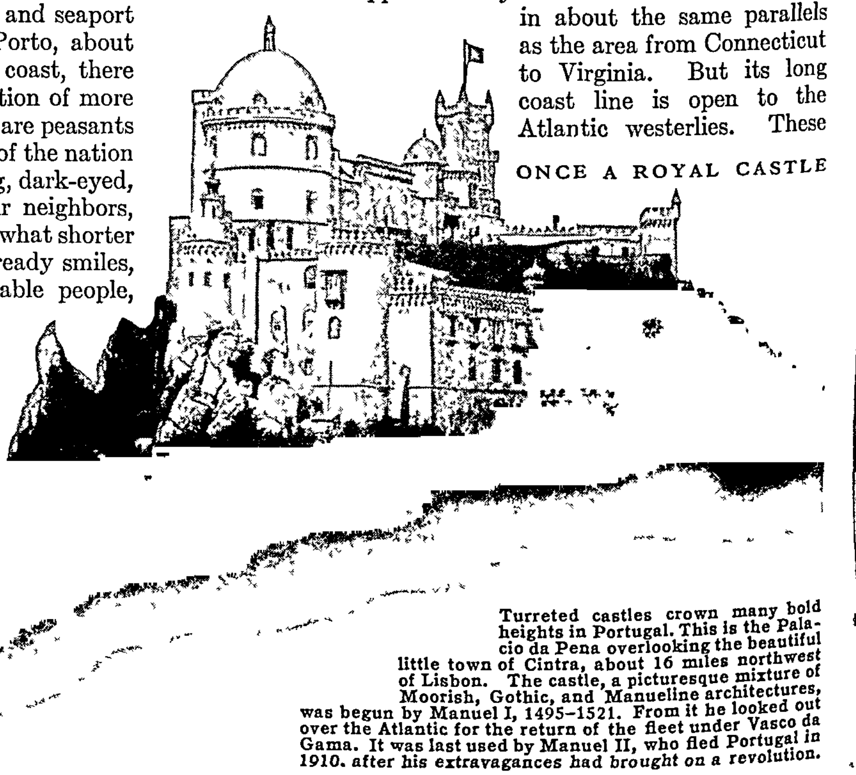
It still has colonies scattered through both hemispheres. Their total population is about 12,400,000. In area, they total about 808,900 square miles, about 23 times larger than Portugal itself. Some have strategic value for air and naval bases and have rich natural resources. But they are little developed, for Portugal even at home is just starting to build modern schools, highways, and industries.

Travelers find that Portugal is like two worlds—one new, one old and picturesque. Its capital Lisbon (Lisboa) at the mouth of the Tagus River on the southwestern Atlantic coast, is a handsome modern city. It is a great air-line center and seaport (*see* Lisbon). But except for Porto, about 180 nautical miles north on the coast, there are no other cities with a population of more than 100,000. Most of the people are peasants and fisherfolk. About two-thirds of the nation is illiterate. Portuguese are strong, dark-eyed, with olive skin like that of their neighbors, the Spaniards. But they are somewhat shorter and more thick-set. With their ready smiles, they are a gracious and hospitable people, often colorfully dressed in costumes traditional with each community.

The geography of Portugal explains the ups and downs of its history. Occupying an outer corner of the Iberian Peninsula, it is the westernmost projection of the European continent into the Atlantic Ocean. On the map, Portugal looks like a narrow pocket patched on western Spain. No sharp natural boundaries divide the two countries. Portugal is largely the western continuation of the rugged plateau (*Meseta*) of central Spain (*see* Spain). Hence it is largely mountainous. The only considerable level land is the narrow plain that extends the length of the Atlantic coast line. Central Portugal, the province of Estremadura in which Lisbon lies, is a plateau, but ridged with hills. The highest of Portugal's mountain ranges, Serra da Estrella, is only 6,532 feet. But even the lower ranges are cut with deep and twisting valleys. Through them many mountain streams, rising chiefly in Spain, race westward to the Atlantic. The principal rivers are the Minho in the north, the Douro flowing into the sea at Porto, the Tagus, and the Guadiana, which flows west and south to form part of the Spanish boundary. (For map, *see* Spain.)

The country's friendly climate encourages easy living. Travelers call it "a land of sunshine." It lies between approximately 37° and 43° north latitude, in about the same parallels as the area from Connecticut to Virginia. But its long coast line is open to the Atlantic westerlies. These

ONCE A ROYAL CASTLE



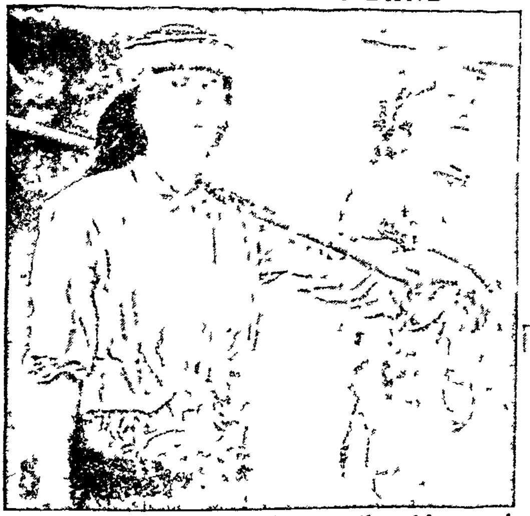
Turreted castles crown many bold heights in Portugal. This is the Palacio da Pena overlooking the beautiful little town of Cintra, about 16 miles northwest of Lisbon. The castle, a picturesque mixture of Moorish, Gothic, and Manueline architectures, was begun by Manuel I, 1495–1521. From it he looked out over the Atlantic for the return of the fleet under Vasco da Gama. It was last used by Manuel II, who fled Portugal in 1910. after his extravagances had brought on a revolution.

provide ample rainfall for farming, and temper the climate. The mean average at Lisbon and Porto is between 60° and 61° F., about the same as that for San Diego, Calif. The sheltered deep valleys, however, are very hot in summer. Much of Portugal's beauty comes from the combination of bright sun and moist air, which gives brilliant color to the flowers, houses, and mountains.

Most of the people dwell on the coastal plain, where the land is easy to work and where the sea affords an abundance of fish. The peasant farmers live in rude houses, usually made of stone and wood, roofed with turf. Roses bloom all year in the yards, and flowering vines brighten the walls. Women do most of the farm work, even plowing with oxen. They earn about 20 cents a day, and the men about 35 cents.

On the many feast days, young and old alike drive to town in high-wheeled oxcarts. There they play guitars, sing traditional melancholy songs called *fados*, and watch bullfights in which the humane Portuguese toreadors never kill or severely hurt the bull. Once a year they make a pilgrimage, *romaria*, to a shrine.

THEY WORK THE LAND



Portuguese peasant women have weathered faces and work-worn hands. They do most of the farm chores. They wear padded hats for carrying head burdens.

Varied Products of Land and Sea

Wheat is the chief field crop, followed by rye, barley, oats, corn, and rice. Fruits and nuts are raised chiefly in the tiny, southern, lush province of Algarve. Grapes for the celebrated Portuguese wines are raised principally on the terraced rugged slopes of the Douro River valley. Great forests of cork oak in the eastern province of Alemtejo make Portugal the world's chief source of cork. It is also a leading producer of olive oil, but this is largely used at home for canning sardines. Fishing for sardines, cod, and tunny is a major industry, centering at Setúbal. Manufactures are now encouraged by the government. The centers are Lisbon and Porto. Their products include shoes, corkware, china, glass, paper, farm tools, fertilizers, olive oil, sugar, and textiles. Portugal has little coal, but its many small swift rivers are being developed for hydroelectric power. It has considerable tin, copper pyrites, sulphur, radium, kaolin, slate, lead, manganese, tungsten, marble, and gypsum.

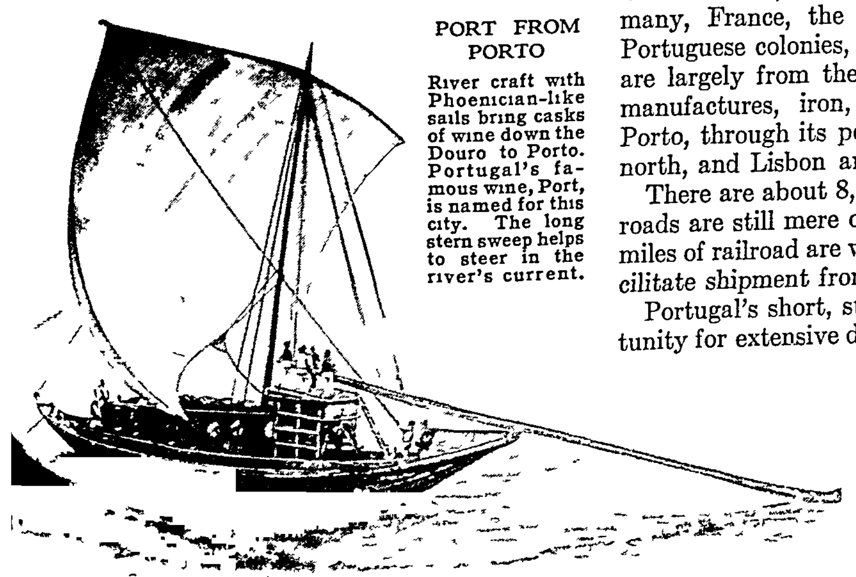
THEY HARVEST THE SEA

Men sail the bright-colored boats of the fishing fleet. Women clean and sell the catch. This Lisbon merchant holds a "spada," a common eel-like fish with vicious teeth.

The major exports are cork, wine, canned sardines, naval stores, olive oil, and textiles. Most of these in normal times go to Great Britain, Germany, France, the Portuguese colonies, and the United States. Imports are largely from the same nations, and are chiefly manufactures, iron, steel, cotton, and petroleum. Porto, through its port at Leixoes, about four miles north, and Lisbon are the centers of foreign trade.

There are about 8,700 miles of highway, but many roads are still mere oxcart tracks. Most of the 2,150 miles of railroad are wider than standard gauge, to facilitate shipment from Spain's similar wide gauge.

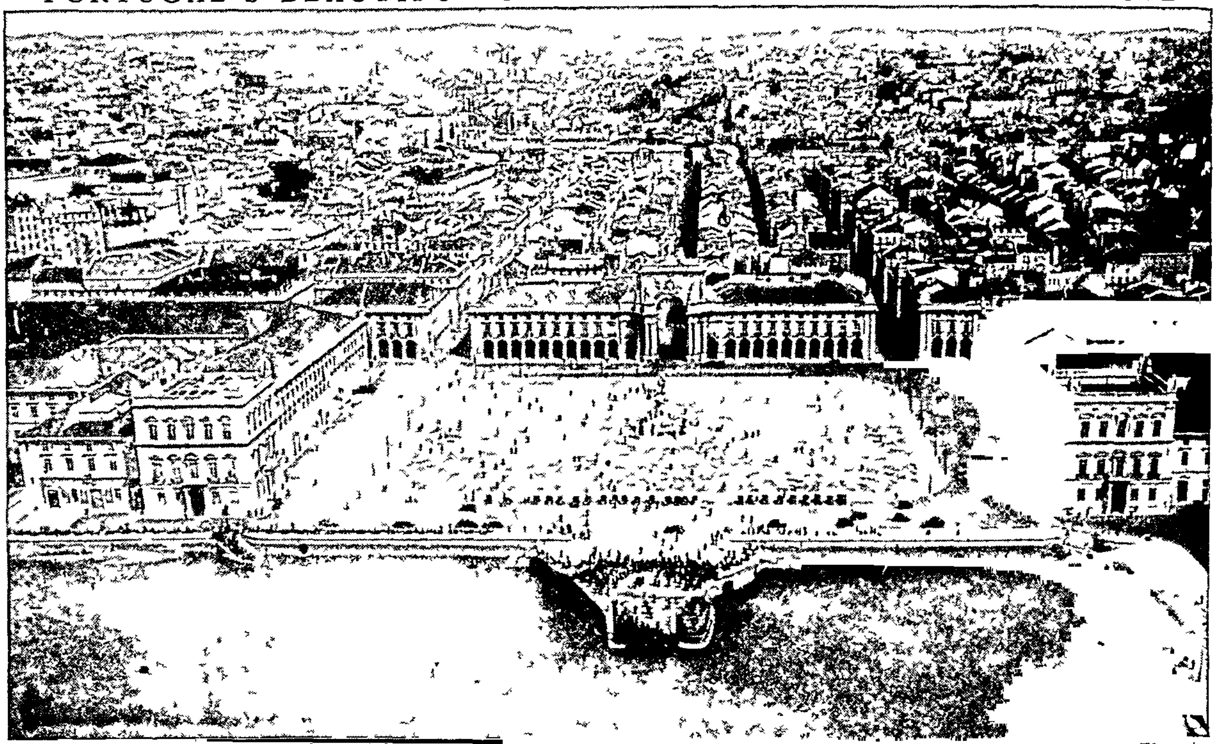
Portugal's short, stormy history gave little opportunity for extensive development of the arts. But the magnificent Battle Abbey, "St. Mary of the Victory," at Batalha is a striking monument to Portugal's rise as an independent nation. It was built by King John I in thanks for his victory over Spain in 1385. Here is the tomb of



PORT FROM PORTO

River craft with Phoenician-like sails bring casks of wine down the Douro to Porto. Portugal's famous wine, Port, is named for this city. The long stern sweep helps to steer in the river's current.

PORTUGAL'S BEAUTIFUL CAPITAL IS A SHOWPLACE OF EUROPE



Lisbon faces a superb harbor, formed by a tidal lake in the Tagus River, about 7 miles from the Atlantic Ocean. The city spreads upward on terraced hills. Its white and pink buildings and bright tile roofs glisten in the clear air. The center of public life is the Terreiro do Paco, the great square shown above. Government buildings line it on three sides. In the center is a statue of Joseph I, 1750–1777, who reigned when Lisbon was rebuilt after being leveled by an earthquake in 1775.

his son Henry the Navigator. Spectacular cathedrals and monasteries in the ornate Manueline style (King Manuel I, 1495–1521) commemorate Portuguese feats of exploration. At beautiful Coimbra is the University of Portugal, founded in 1290. It is celebrated for its atmosphere of "noble scholarship." Here studied Luis de Camoens (1524–80), who became Portugal's great poet through his *Lusiads*, an epic describing the triumphs of Vasco da Gama.

Like Spanish, the Portuguese language springs from the Roman. Portuguese uses nasal vowels, and is pronounced more like French. The mark ~ (*til*), represents *n*. Hence *irmã* ("sister") is pronounced *irman; são* (saint) is pronounced *soun*. It is a contracted language, yet it is more musical than Spanish, for Portuguese voices are softer.

The early history of Portugal is the history of Spain (*see* Spain). Under Roman rule, Portugal was merely the western part of the province of Lusitania. Its present name came from Portus Cale ("Door of Cale"), a seaport now a suburb of Porto. The first step toward independence came in 1095. In that year what is now Portugal was given to Count Henry of Burgundy as part of the dowry of his wife Theresa, Spanish princess of Leon. In 1131, a year after her death, her son Alphonso I began a series of wars to win freedom. His victories ended in the Treaty of Zamorra, 1143, in which Spain recognized the new nation.

The period of Portugal's greatness began with Europe's Golden Age of Discovery. For centuries the Portuguese had grown up with the sea. When southern Europe knew little but the waters of the Mediterranean, the Portuguese were venturing along the Atlantic coast. This gave them enormous advantage, when Europeans began seeking new sea routes to the Indies. The Portuguese navigators were ready to lead the way.

These men of the sea had been given the best available training and equipment by their patron Prince Henry the Navigator (*see* Henry the Navigator). Daring but seasoned, Portuguese captains began sailing down the coast of Africa, then around Africa to the Orient, and then west to Brazil. Bartholomew Diaz and Vasco da Gama were among them. They conquered an immense empire (*see* Brazil; Diaz, Bartholomew; East Indies; Gama, Vasco da). During the 16th century Portugal dominated Europe's trade with riches from its colonies (*see* Trade).

But the Portuguese were not empire builders. They tried to hold their colonies with garrisons alone. They failed to send out men to develop the natural resources of their possessions. The empire was too vast and too scattered to be held together from afar by Portugal's feeble military power. Other nations were soon disputing its possessions. In 1580 the Portuguese royal family died out. The throne was at once claimed by Philip II of Spain, who seized it in 1581. Not until 1640 did the "years of captivity" end, when Portugal threw off the Spanish yoke. By that time only fragments of its colonies were left. In 1703 the Methuen treaty joined Portugal and England in a

commercial-political pact which became the longest-lived alliance in modern European history.

When Napoleon Bonaparte overran the Iberian Peninsula in 1807, the Portuguese king (John VI) and royal family fled to their great South American colony of Brazil. The British under Wellington threw back the French in what is known as the Peninsular War (1808–14). But the king did not return until 1822, and in that same year Brazil became an independent empire under his son, ending Portuguese power in the New World (*see* Brazil).

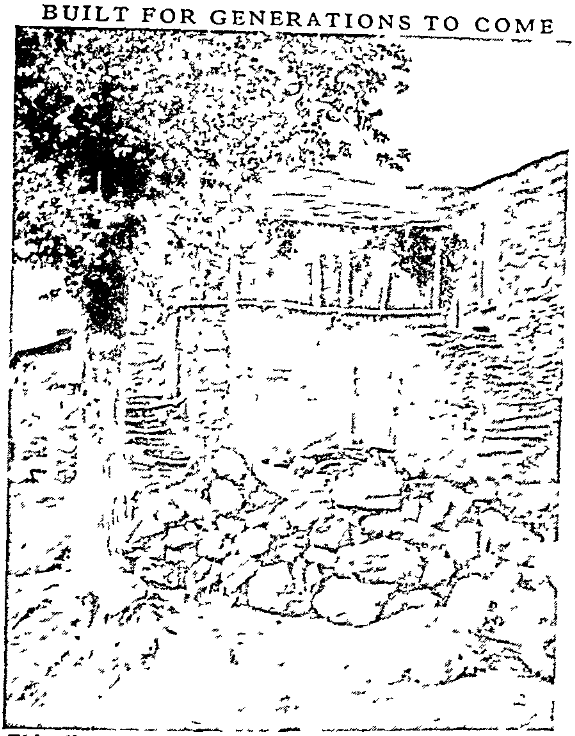
Even leaner years followed. Portugal plunged into bankruptcy in 1892. Dictatorship and revolutions ensued, bringing the abdication of King Manuel II in 1910 and the declaration of a republic. Internal dissension continued, but at the outbreak of the first World War Portugal sent troops to aid its ally England. Civil strife persisted until 1926 when a military dictatorship gained control. Antonio Oliveira Salazar, professor of economics at Coimbra, was appointed minister of finance. In 1932 he became prime minister, and in 1933 civilian dictator.

A new chapter in the history of Portugal began. Salazar promulgated a new constitution. It established Portugal as a corporative state, modeled in some respects on fascist Italy. It provided for a president, a cabinet, a national assembly, elected half by popular vote and half by economic corporations, and a corporative chamber. The state largely controls business and industry and has pushed economic development. But little has been achieved in education.

In the second World War Portugal was neutral. Its small forces could not hope to defend its far-flung colonies. Under the Methuen alliance, British troops tried vainly to defend Timor Island. After the war a controlled election in 1945 upheld Salazar. In 1947 he put down a military revolt. Portugal joined the European Recovery Program in 1948 and signed the North Atlantic Treaty in 1949. In 1952 it announced a "joint defense front" with Spain. (For Reference-Outline and Bibliography, *see* Europe.)

POSEIDON (*pō-sī'dŏn*). In the days of ancient Greece, Poseidon, god of the sea, was supposed to hold court with all the sea divinities in his golden palace in the depths of the Mediterranean. The Nereids and Tritons attended him when he rode in his sea-shell chariot. Dolphins played about his car, and at its approach the restless ocean waters grew calm. In his hand Poseidon carried his trident, a three-pronged spear, the symbol of his power. With one stroke of this, the mighty sea-god could shatter rocks, cause earthquakes, call forth storms, or lash the sea to such fury that the very earth shook with the beating of its waves. Mariners prayed to him as the giver of calms and of favoring winds, and in his honor erected temples on jutting headlands, and made sacrifices of rams and great black bulls. Poseidon was also god of all rivers and ruler of the lesser divinities of streams, springs, and fountains.

BUILT FOR GENERATIONS TO COME



This limestone house is a typical peasant dwelling. The rugged mountains furnish an abundance of stone. Live stock is kept in the lower portion, near the open-fire kitchen where savory meals are cooked.

But for all his power, Poseidon was subject to the will of his brother Zeus, who was king of gods and men, and by whom he was once condemned to live for a year on earth among mortals.

It was at this time that Poseidon agreed with Laomedon, king of Troy, that for certain rewards he would build that city's mighty wall. In Homer's 'Iliad' Poseidon, speaking to Apollo, reminds that god how basely the Trojan king had treated them. "I round their city built a wall," he says, "wide and most fair, that the city might be unstormed; and thou, Apollo, didst herd shambling, crook-horned kine among the spurs of woody, many-folded Ida. But Laomedon robbed us of all hire, and sent us off with threats. He threatened that he would bind together our hands and feet and sell us into far-off isles, and the ears of both of us he vowed to shear off with his sword. So we went home with angry hearts, wroth for the hire he promised and gave us not."

Poseidon revenged himself at the time by sending a great sea monster to ravage the plain of Troy; but Heracles (Hercules) slew the beast, and Poseidon nursed his grievance until the Trojan War. In that conflict between the Greeks and Trojans, Poseidon was always on the side of the Greeks, helping and encouraging them until at last the city lay in ruins. But on the return voyage of the Greeks to their native land Poseidon was hostile to Odysseus (Ulysses) and helped cause the ten years' wanderings of that much enduring hero (*see* Odysseus).

The Greeks believed that Poseidon was the son of Kronos and Rhea, and was the brother of Zeus and Hades, who ruled the world of earth and the underworld of the dead, as Poseidon ruled the sea. The Romans identified Poseidon with their god Neptune.

The MAILMAN—MESSENGER *for the* WORLD


The mailman is one of our public servants. He visits us almost every day to bring letters, postcards, magazines, newspapers, and parcel post packages.

POST OFFICE. Through the mail anyone can exchange messages with friends near by or on the other side of the world. Businessmen, lawyers, engineers, and others carry on much of their business through the postal service. Mail service is one of the world's great public utilities.

Your Mailman

In a city or town a *mailman* goes by each house every day. He is identified by his blue-gray uniform and the bag he carries. (The post office calls the bag a *satchel.*) If he has mail—a letter, a postcard, a magazine, newspaper, or small package—addressed to your house he stops to put it in your mailbox. If you wish to mail a letter, he will pick it up and take it to the post office. He may collect mail from some of the street mailboxes on his route.

The mailman starts work at about 6:30 A. M. During the night and the early morning, clerks in the post office have separated the mail into racks for the different mailmen. Each mailman must arrange the mail in his rack in the order of addresses along his route. This takes him from one-half to a full hour.

A mailman is not allowed to carry more than 35 pounds in his bag at one time. But he may deliver several times 35 pounds in a day. If his load weighs more than 35 pounds, he starts with the mail for the first part of his route. He ties the rest into bundles and puts them into canvas mail sacks. A truck driver will take these sacks and put them in storage boxes along the route. Storage boxes are painted green and look very much like big street mailboxes, but they do not have letter or package drops. The mailman picks up his new loads from these storage boxes.

If a mailman's route starts within a few blocks of the post office, he walks to it. If it lies farther away, he rides a mail truck, a streetcar, or a bus. The mailman does not pay the streetcar conductor or the bus driver for his ride. Once a year the post office pays a lump sum to the transportation company.

Special Kinds of Service

Mailmen who deliver in the business districts have shorter routes because they have so much mail to deliver. In a very large building a route may be only two or three floors. Mailmen may make as many as three deliveries a day in business districts.

Some mailmen drive trucks to collect mail from street boxes. A card on the front of each mailbox shows the times throughout the day when mail will be collected from the box.

Other truck drivers deliver all but the smallest *parcel post* packages. If a package has been insured for more than $5.00, the driver gets a receipt for it.

Some mailmen drive a motorcycle or car to deliver *special delivery* letters and parcels. The *rural route* mailman takes mail to people who live outside cities and towns. He always carries a supply of stamps and money order application blanks for anyone who wants them. Most special delivery and rural delivery mailmen own the cars they drive.

The clerks at the post office windows sell stamps and money orders, receive postal savings, register letters, weigh and insure parcel post packages, and give out postal information. In large city post offices there will be a window for each service. In small post offices several or all these services will be offered at one window.

Handling Mail in the Post Office

Handling mail in a large post office is highly skilled work. As mail is brought in from mailboxes it is dumped on a *facing table.* Separation clerks place air mail in one place, large first-class envelopes in another, and small first-class envelopes in a third. All envelopes are "faced" in one direction, with the stamps in the same corner. The large and small

HOW THE POST OFFICE DELIVERS A LETTER

The pictures show how the postal service delivers a letter to a friend in a faraway city. At the post office where the letter is mailed, it is postmarked and placed with other letters going to the same city. When the letter gets there it is sorted and a mailman delivers it to the friend's mailbox.

envelopes are separated because the canceling machine must be adjusted to the envelope size.

The canceling machine *postmarks* more than 500 letters a minute. It prints black lines (the *cancellation*) over the stamp and near it a circle. In the circle is the name of the city and state, the date, and the time of day or night.

Next the letters go to the *primary separation* clerks. They separate the letters according to states or regions. The primary separation racks in some cities have pigeonholes for "heavy mail" cities such as New York and Chicago. Letters for the heavy mail cities go directly into pouches addressed to those cities.

The letters in the state and region pigeonholes go to the *secondary separation* clerks. Each one is skilled in separating mail for a particular region. He knows what train to use for each city and town in the region, and when each train leaves. He has a pouch for each post office which gets mail enough to justify it. Just before each train leaves he closes, seals, and addresses every pouch that goes on the train. Many post offices in small towns do not get mail enough to make a pouch worthwhile. This mail goes into a pouch addressed to the RPO (railway post office) car on the train. Clerks on the car sort the mail.

Mail for local delivery is sorted by clerks who know the city routes. In larger cities mail first must be separated according to *zones*. Usually there is one zone for each branch post office. If the *zone number* is in the address, this helps greatly in sorting the mail. There are two correct ways to write addresses:

John A. Doe 4515 River Street Chicago 47 Illinois	John A. Doe, 4515 River Street, Chicago 47, Illinois.

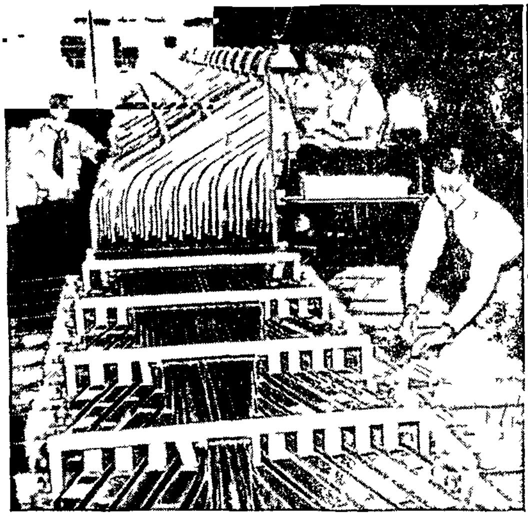
Parcel post is separated in much the same way as letter mail, except that clerks throw the packages directly into open mail sacks. In large cities a clerk's job is highly specialized. In smaller cities one clerk may separate all classes of mail. Clerks and carriers must pass the same civil service examination. After a clerk starts work, he is tested once a year for skill in separating mail.

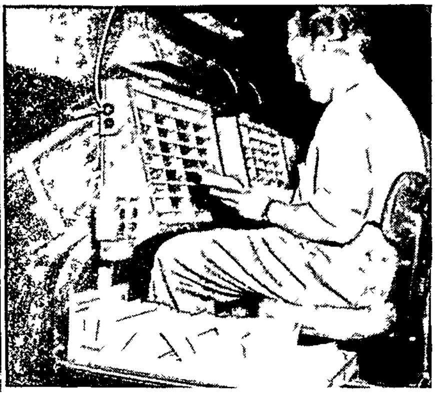
Large newspapers, magazines, and mail-order companies have post office units in their plants. These units separate and sack the mail matter and take it directly to the railroad stations.

The post office has many aids for handling business mail. These include precanceled stamps, envelopes with printed cancellations, and mailing meters. Mailing meters are made by private concerns, who rent them to business firms. The meter prints the amount of postage directly on the envelope. The meter also prints adhesive strips of desired denominations. These are used on bulky matter. The post office sets the meters to print the amount of postage bought in advance by the renter.

Mail without an address, with an incomplete address, or with an address that cannot be read goes to the nearest *dead-letter office*. There the mail is opened to see if the contents contain a clue to the sender or addressee. Often money and other valuables are

A HUGE AUTOMATIC MACHINE SORTS THE MAIL





Above, a clerk puts letters into a giant sorting machine. Each slot lets letters down to one of the guides in the foreground at left. The letters fall on a moving belt and are held on edge by the guides until they reach a collecting spot. There they join other letters going to the same region.

found inside. The dead-letter mail is held a reasonable time for senders to claim it. If no claim is made, the valuables are sold at auction.

Safeguarding the Mail

The postal service has its own police department. The policemen are called *postal inspectors.* They watch constantly for criminals who use the mails to defraud, and they work with other police agencies to detect and arrest criminals who steal from the Post Office Department.

Many post offices have passageways between their walls. Only postal inspectors are permitted to enter these passageways. Through holes the inspectors can watch clerks and carriers at work. Occasionally an inspector must arrest a clerk or carrier he has seen stealing money from an envelope or goods from a package.

How Mail Is Transported

The *Postal Transport Service* of the Post Office Department supervises the transportation of the mail. Many kinds of transport are used, but most of the mail is carried by the railroads. In the cities each post office has its own fleet of trucks. A few very large cities send mail from station to station through underground pneumatic tubes. Other means of transport are highway post offices (busses), trucks, horses, dog sleds, steamships, and airplanes.

Some fast trains are made up entirely of mail cars. Other trains have only one car. Cars that haul pouched and sacked mail from one point to another are called *storage cars.* Those in which mail is separated as the train travels are called *railway post offices. Railway mail clerks* open pouches and sacks, separate the contents, and make up new pouches and sacks. Some mail is taken on and some dropped off at each station stop. The mail dropped off will be delivered to local addresses or put aboard a connecting train to be carried on to other towns and cities. As the RPO speeds through small towns, the clerk uses a steel hook to catch a mail pouch from a stand beside the track. At the same time he throws out a pouch with mail for that station. Railway mail clerks know the schedules of hundreds of trains. They may decide to carry a city's mail a hundred miles past a junction that has a rail connection to the city. They do so because at the end of the hundred miles there is another connection with a train that will reach the city sooner. Every railway mail clerk is armed with a pistol.

In areas with poor rail connections and between post offices of near cities, the department uses *highway post offices* and trucks. In rural areas the department hires a truck owner to carry mail to towns

A LANDSLIDE OF CHRISTMAS PRESENTS

Great moving belts bring Christmas parcel post packages to the separating floor of Chicago's post office. Here the separation clerks read the address on each package and put each one into a mail bag with other packages going to the same town.

and cities without rail lines. Some of these drivers also deliver mail to farmhouses along their routes. These routes are called *star routes.* The highway post office has the same uses as a railway post office. As its driver directs it along the road, the clerks in the body of the bus separate the mail.

Steamships carry mail over wide stretches of the ocean. In their holds is mail for distant parts of the world. The steamships are not owned by the Post Office Department; their owners contract to carry the mail.

Fastest of all mail transports are the *mail planes.* All large American cities have air-mail service. Great four-motored planes fly mail above the ocean to Australia, New Zealand, Hawaii, the Philippines, Japan, Asia, Europe, Africa, and South America. An air-mail stamp will send a letter almost anywhere in the civilized world.

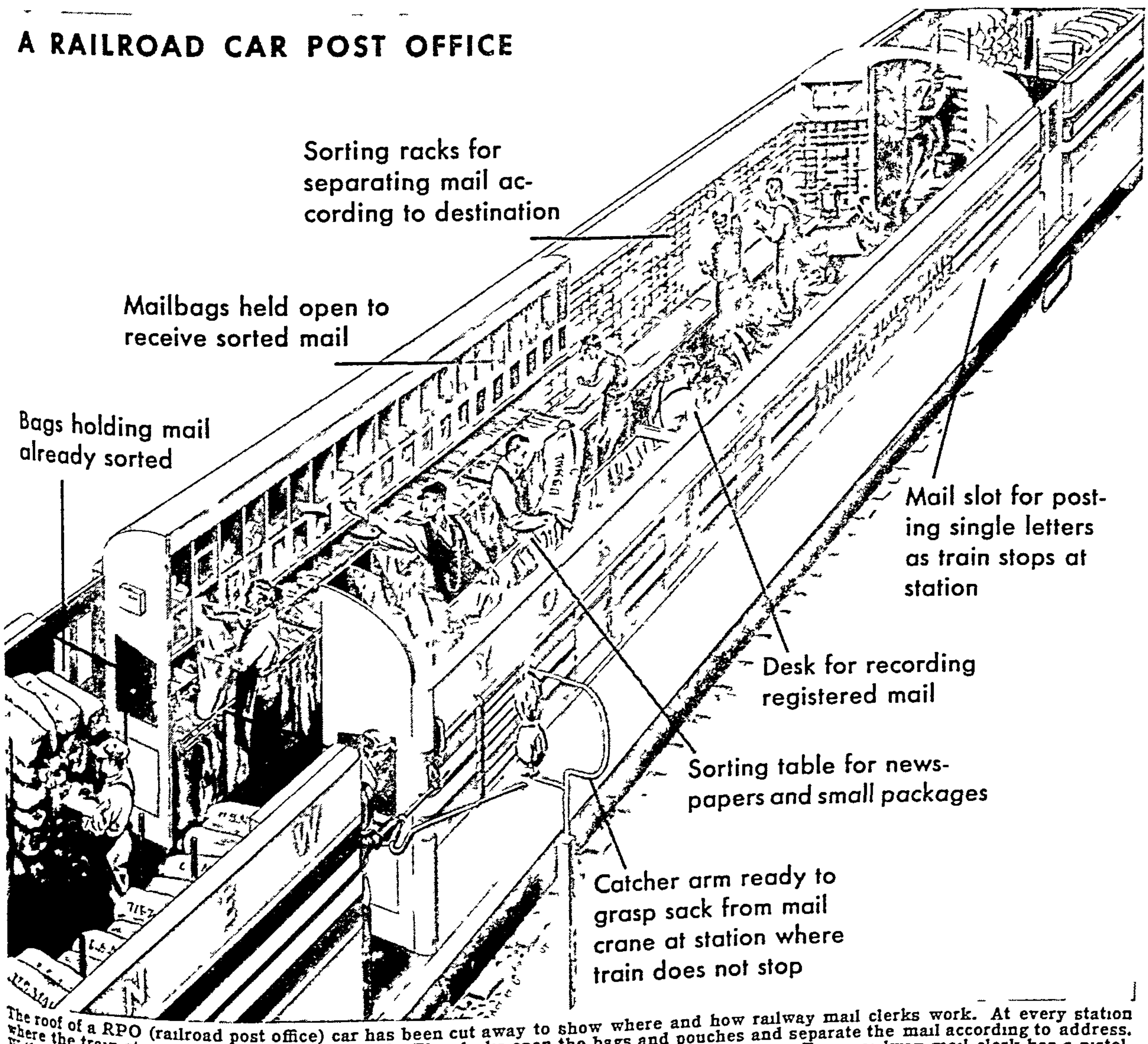
Some great city post offices, like Chicago and Los Angeles, send mail-loaded helicopters soaring from their roofs to carry mail to planes at airports. This saves precious minutes that would be lost by mail trucks trying to get through traffic-tangled streets. Helicopters also fly to near-by towns to deliver and pick up air mail. (*See also* Transportation.)

How Postal Service Was Started

The Book of Job, in the Old Testament, speaks of *posts.* This is the first mention we know of postal service. Job's post existed some 1,700 years before Christ. The Bible mentions other posts. In the fifth century B.C., Confucius tells of a Chinese post; this was about the time of Cyrus' system.

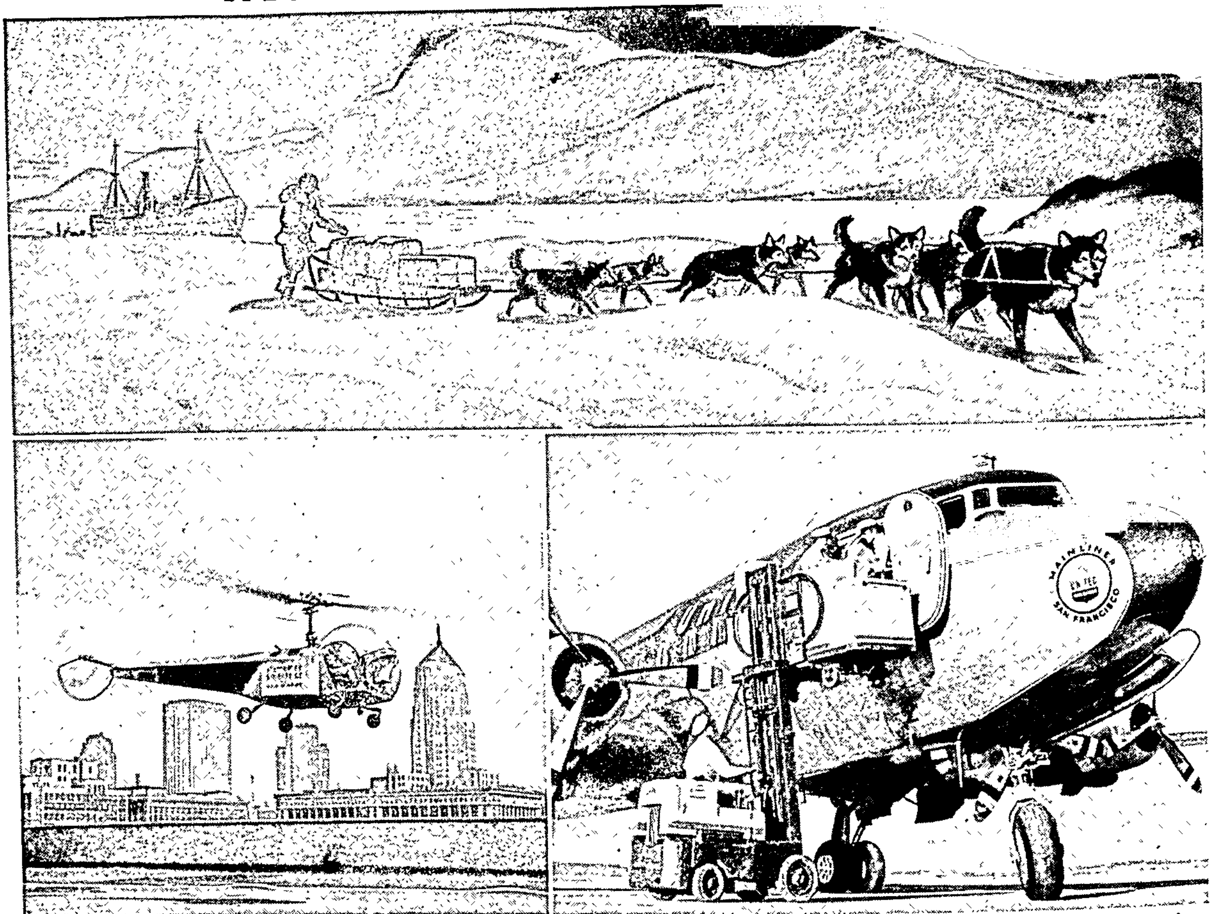
Five hundred years before Christ was born, Persia's great emperor Cyrus had post riders—that is, horsemen who carried dispatches. Herodotus wrote of these riders. ". . . and neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds. . . ." Today these words are carved in stone on many of the great post office buildings.

A RAILROAD CAR POST OFFICE



The roof of a RPO (railroad post office) car has been cut away to show where and how railway mail clerks work. At every station where the train stops more mail comes aboard. The clerks open the bags and pouches and separate the mail according to address. With the catcher arm a clerk can pick up mail from stations where the train does not stop. Every railway mail clerk has a pistol and other firearms are in the car for use against mail robbers

SPECIAL WAYS FOR DELIVERING THE MAIL



At the top an Alaskan mailman drives his dog sled away from a ship. He and his dogs will deliver mail to isolated people along his icy route. At the left a helicopter rises from the roof of the great Chicago post office. It is loaded with mail for mail planes which go in every direction from the airport. Helicopters also carry air mail to and from suburban cities for 50 miles around the city. At the lower right a special loading machine hoists mail into a mail airplane.

The word "post" comes from the Italian *posta,* meaning a station or fixed place. Posts were a day's journey apart, or closer on important routes. At the posts one courier turned his messages over to another or proceeded on a fresh horse. Early couriers carried messages only for the ruler and high government officials.

Notable postal services were maintained by the Roman Emperor Augustus, by Emperor Charlemagne of the Holy Roman Empire, and by the famous German house of Thurn and Taxis. Two American Indian peoples used a post system before Columbus discovered America. The Aztecs posted fish to inland villages, and in their sacks Inca messengers carried lima beans on which messages were marked.

Probably the first real postal system was established in 1464 by King Louis XI of France. Postal messengers were dispatched regularly. An English system was started in 1523 but was used only by members of the royal family. During the reign of Elizabeth I another mail service was started.

The University of Paris had a system in the 12th century to deliver students' messages to their homes. The Hanseatic system carried merchants' messages between the trading cities (*see* Hanseatic League). Genghis Khan's mounted messengers rode over a vast area of mountain and desert between China and European Russia.

These early posts could not be used by the public. Some private posts were set up to serve the people. In 1591 Queen Elizabeth I ruled that only the government post could carry Englishmen's messages overseas. This ruling was made to impose censorship. In early days postal officials opened and read almost all letters.

In 1635 Thomas Witherings established the first actual post office in London. He also set up a system of post riders throughout the British Isles. In 1680 William Dockwra formed a London company to deliver mail for only an English penny. This successful system was taken over by the government.

In colonial America the first government post was set up in 1639 in the Boston home of Richard Fairbanks. He was responsible for delivery. In 1672 a monthly post between New York City and Boston began over what is now the Boston Post Road (U.S. Highway 1). Philadelphia set up a post office in 1683. This same year a post route from Maine to Georgia

MAIL SERVICE TO FARM AND VILLAGE

At left a farm boy and girl receive mail at their mailbox from the rural route mailman. He makes his rounds six days a week. At the right, a village postmaster cancels letters with a hand stamp. His assistant hands a letter to a patron through the window: This is a fourth-class post office and does less than $1,500 worth of business a year.

was opened. Virginians relayed mail from plantation to plantation until each letter reached its addressee.

The first postmaster general for the American Colonies was appointed by the British king in 1691. Benjamin Franklin became the Philadelphia postmaster in 1737, and in 1753 he was made postmaster general for the northern colonies. Under him the colonial postal service earned its first profit.

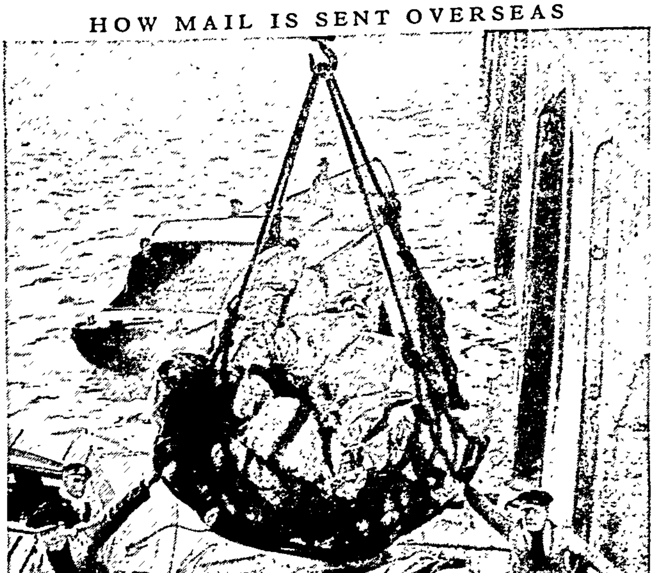
In 1775 the Continental Congress appointed Franklin head of the American postal system. The first United States postmaster general, Samuel Osgood, was appointed in 1789 by George Washington. The postal service was then under the Treasury Department. It became a separate department in 1820.

The Beginnings of Cheap Postal Rates

Even well into the 19th century most countries had involved systems of postal rates. Usually the receiver of mail paid for delivery; the charge depended on the distance the mail was carried. Governments looked upon the post as a source of income.

In 1836 an Englishman, Rowland Hill, published a pamphlet on postal reform. In it he asked that a half-ounce letter be charged only a penny for delivery anywhere in England and that the penny be paid by the sender. He suggested that the government sell postage stamps and postage-paid envelopes.

HOW MAIL IS SENT OVERSEAS



Mail sacks are swung aboard an ocean-going steamship. Steamship companies make contracts to carry mail to all ports of the world. They earn a good part of their income by carrying mail.

Hill's reforms were set in operation in 1840. The world's first postage stamp was sold in London that year (*see* Stamp and Stamp Collecting). Other countries began to follow the English example.

In the United States, postal service had greatly improved. In 1798 it had required 40 days to send a letter from Portland, Me., to Savannah, Ga. In 1839 only eight days were needed. In 1839 a *Pony Express* between the Eastern seaboard and St. Louis was established. The express was extended into the South. The service was speedy for its day; it averaged almost 12 miles an hour. The charge for Pony Express service was three times that for ordinary mail. In 1862 the St. Joseph, Mo., postmaster experimented with separating mail aboard a train bound for Hannibal, Mo. The first

official test of a railway post office took place aboard a train from Chicago to Clinton, Iowa, on Aug. 28, 1864. As railroads were built, they took over more and more of the work of carrying the mail

The United States Post Office Department issued postage stamps in 1847, but postal charges still were often paid at the receiving end. It was not until 1855 that prepayment of postage was made obligatory. The same year the *registry* system was started. Street mailboxes were introduced in 1858.

HONORING THE WORLD POSTAL UNION

This statue stands in Bern, Switzerland. It honors the formation of the Universal Postal Union in Bern in 1874 The figures clasping hands represent the continents The group expresses international cooperation in carrying the mail.

In 1860 a private contractor revived the Pony Express to carry mail over the vast stretches of prairie and mountain between St. Joseph, Mo., and Sacramento, Calif. He charged $5.00 for each half ounce; later the charge was reduced to $1.00. The fastest trip took seven days and seventeen hours. The most important message carried on the record trip was President Lincoln's first inaugural address. The Pony Express was discontinued in October 1861.

Over the years the Post Office Department has added many important services. Among these are:

Free home delivery	1863	Coast to coast air mail	1920
Railway post office	1864	Foreign air mail	1920
Money orders	1864	Transpacific air mail	1935
Postal cards ..	1873	Transatlantic air mail.	1939
Special delivery	1885	Highway post office	1941
Rural free delivery .	1896	Zone numbers	1943
Postal savings .. .	1911	Air letter sheet	1947
Parcel post	1913	Helicopter air mail	1947
Insurance	1913	Air parcel post	1948
C O D	1913	Streamlined money order ..	1951
Air mail .	1918		

In the *C.O.D.* (cash on delivery) service the Post Office Department acts as a collecting agent for merchants who wish to deliver goods by mail. The punched card of the *streamlined money order* can be cashed at any post office or bank. The *air letter sheet* is folded to form an envelope and it can be sent almost anywhere in the world for only ten cents.

Government offices send mail without stamps in *penalty envelopes.* In the stamp corner of this envelope are printed the words: "Penalty for private use to avoid payment of postage, $300 (PMGC)." The president, Cabinet members, past presidents and their wives, and members of Congress may send mail free. In place of a stamp the mail matter carries the signature or printed facsimile signature of the person so privileged. This is called *franking.* During the second World War all members of the armed services were granted the franking privilege.

The United States Post Office Department

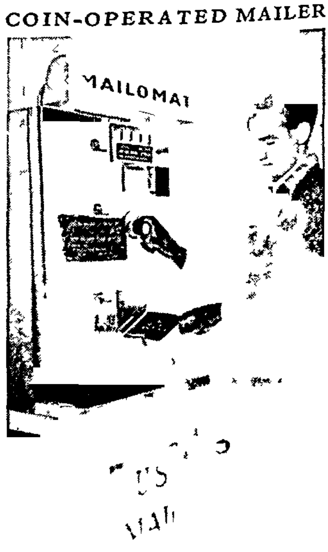
The postal service is headed by the postmaster general, a member of the president's Cabinet. His chief aids are a deputy postmaster general and an administrative assistant Four divisions of the department are headed by assistant postmaster generals. These are the Bureau of Facilities, Bureau of Post Office Operation, Bureau of Transportation, and Bureau of Finance.

The department has some 42,000 post offices and about 500,000 employees. It is the world's biggest public utility Some 40 billion pieces of mail are handled every year. The revenue is more than $1,400,000,000, but the department spends more than this.

There are four classes of post offices. In the first are those with an annual revenue of more than $40,000; in the second, those with a revenue between $8,000 and $40,000; in the third, those with a revenue between $1,500 and $8,000; and in the fourth, those with a revenue of less than $1,500. About three-fourths of the total are fourth class.

Fourth-class postmasters are appointed by the postmaster general. Others are appointed by the president. Until the late 1930's appointments were political favors. Now postmasters usually are appointed from among postal workers on a basis of ability and experience. All postal workers hold their jobs under civil service rules and regulations.

COIN-OPERATED MAILER



The mailomat takes a letter, stamps and postmarks it, and drops it into a collection box.

The Universal Postal Union

In 1862 the postmaster general of the United States suggested to other nations that they join in unifying postal services and rates. Many governments sent representatives to a conference in Paris in 1863. In 1874, 22 na-

tions joined to establish the *General Postal Union*. Other countries requested entrance; today almost every nation is a member. In 1878 the name was changed to *Universal Postal Union*. The union headquarters are in Bern, Switzerland. Representatives of the member nations meet every few years to solve the problems that arise. Member countries deliver letters without receiving a part of the postage paid in another country. This is because there is about an equal amount of mail between any two countries.

The nation members of the union are permitted to make special agreements among themselves. Great Britain has such agreements with its colonies, territories, and its affiliated nations. The United States has agreements with Canada, Latin American countries, and Spain. The agreements permit mail to be sent between these countries at low rates In 1950 the United Nations established a postal system of its own, principally to make money from stamp sales. Its mail is handled by the United States Post Office.

THE CLASSES OF MAIL MATTER AND POSTAL RATES

First Class. Postal cards, letters, and any matter sealed against inspection	
Out of city delivery (rate per ounce or fraction of an ounce)	3¢
Local delivery having letter carrier service	3¢
Local delivery having postoffice boxes but no carrier service	2¢
Postal cards (each)	2c
To Canada and Mexico	3¢
Postal cards (each)	2¢
To other foreign countries (for first ounce)	8¢
For each additional ounce	4¢
Postal cards (each)	4¢
Air Mail. United States and possessions, Canada, Mexico (each ounce or fraction to include 8 oz —to Canada, up to 60 lbs , to Mexico, up to 4 lbs 6 oz)	6¢
Postal cards (each)	4¢
International air letter (stamped letter sheet)	10¢
South America (per ½ oz)	10¢
Europe (per ½ oz)	15¢
Asia, South Pacific, southern Africa (per ½ oz)	25¢

Second Class. Used for newspapers and periodicals For the general public the second-class rate is 2¢ for the first 2 oz or fraction and 1¢ for each additional 2 oz , or the fourth-class rates if lower

Third Class. For matter weighing 8 oz or less, except 1st and 2d class
Merchandise and loose printed matter, 2¢ for first 2 oz or fraction thereof, and 1¢ for each additional ounce or fraction up to 8 oz.
Books and catalogs of 24 or more bound pages, seeds, cuttings, bulbs, roots, scions, and plants, 2¢ for first 2 oz and 1½¢ for each added 2 oz
Bulk mailings (not less than 20 lbs or not less than 200 separately addressed identical pieces) may be sent at low rates by special permit

Fourth Class, or parcel post All matter except first and second class weighing over 8 oz and up to 40 lbs for local, first, and second zones, and up to 20 lbs for other zones The limit of size is 72 inches in length and girth combined Rates vary according to distance for example, local delivery, 18¢ for 1 lb up to 75¢ for 40 lbs , 8th zone (over 1,800 miles), 32¢ for 1 lb. up to $3 75 for 20 lbs For special sizes, weights, and rates for parcels to or from rural areas and between 2d, 3d, and 4th class post offices, consult your postmaster
Air parcel post 60¢ to 80¢ a pound according to distance, and 48¢ to 80¢ for each additional pound
Books permanently bound and containing no advertising except incidental announcements of other books, 8¢ for 1 lb up to $2 84 for 70 lbs
Single catalogs and similar printed advertising matter, individually addressed, with 24 or more bound pages and not exceeding 10 lbs 10¢ to 18¢ a pound according to distance, and 1½¢ to 11¢ for each additional pound.

POTASSIUM. Man could get along without silver or gold, but without potassium, animals and plants could not live. No one had ever seen this metal until Sir Humphry Davy obtained it from fused potash by electrolysis in 1807. The reason is that this element is never found alone, and it is difficult to isolate it from its compounds.

Potassium is a soft, silvery-white metal, which can be readily molded and cut with a knife. It oxidizes instantly in air. It belongs to the group of alkali metals. These include sodium, lithium, and the rarer rubidium and cesium. Each one forms compounds readily, so laboratories keep them under oil to exclude moisture and oxygen (*see* Alkali Metals). When potassium comes in contact with water it reacts violently by seizing the oxygen and part of the hydrogen to form potassium hydroxide (caustic potash). The process generates so much heat that the leftover hydrogen bursts into flame and in burning becomes water again.

Caustic potash is used in making glass and soap. Originally it was obtained from lye produced by boiling plant ashes in a pot. This explains the name "pot-ash." Today the world needs vastly more potash for use as fertilizer than could be produced in this way. The United States alone uses over 1,000,000 tons of potash salts every year. In raising such crops as cotton, tobacco, sugar cane, and potatoes, potash compounds are especially valuable In fact, practically all plants use more or less potash, which increases their size and vigor. Although potash compounds are plentiful in nature, most of the potassium is locked up in insoluble silicates in the rocks. The "weathering out" process gradually releases them into the soil but too slowly to meet modern agricultural needs. So the supply must be artificially increased.

With the exception of the silicates, most naturally occurring potassium compounds are soluble in water. Rains dissolve them from the soil, and rivers carry them into the sea. There they are diluted and mixed with other salts, and separation is not feasible. Sometimes, however, streams have carried potassium salts into lakes, and the lakes have dried up. This leaves a concentrated deposit, and the salts can be recovered profitably. Searles "Lake" in California is a great deposit of dazzling white crystals, impregnated with brine. This remnant of an inland sea contains about 12 square miles of salts 60 to 70 feet deep.

Other lakes, evaporating in earlier geologic ages, left beds of crystallized potassium salts. These deposits were protected from rain by deep layers of silt that hardened into rock. Deposits found in Germany supplied the demand for years.

In the first World War the world suddenly realized that the German beds were the chief source of supply. The United States hastily built factories to extract potash from the mineral alunite, found in Utah; from volcanic lava, leucite, found in Wyoming; from potash shales in Georgia and greensand in New Jersey; from brines of salt lakes and marshes in Nebraska, Utah, and California; from seaweeds or kelp on the Pacific coast; and from trade wastes, such as cement kiln dust and the residue from alcohol distillation. Most of these plants were forced to close when cheap foreign potash again came onto the market.

In 1931 development of deposits in New Mexico began, and by 1950 they furnished 85 per cent of the needs of the United States. The chief foreign producers are Germany, France, Spain, Russia, and Israel.

Potassium nitrate (KNO_3) supplies both potash and nitrogen for fertilizers and is used in making gunpowder. Its chloride (KCl), used in preparing other potassium salts, is also used in fertilizers. Caustic potash, or potassium hydroxide (KOH), is used chiefly in making soft soap. Potassium chlorate ($KClO_3$), as a source of oxygen, goes into fireworks, flashlight powder, safety matches, and explosives. The bromide (KBr) and the iodide (KI) aid photography and medicine. Potassium cyanide (KCN) is an agent for extracting gold from low-grade ores and a source of hydrocyanic gas, or "prussic acid," a poison used in fumigating. The carbonate of potassium (K_2CO_3) is used chiefly to make hard glass and soap. The metal is generally prepared by electrolysis of fused caustic potash. (*See also* Fertilizers; Sodium.)

The WORLD'S *Second* MOST IMPORTANT *Food Crop*

POTATO. The world grows more than 8 billion bushels of potatoes in an average year. Next to wheat, potatoes are the most important food crop. In Europe they are used as food for both human beings and animals. In America only small amounts are used as cattle feed. Both Europe and America obtain industrial products from potatoes.

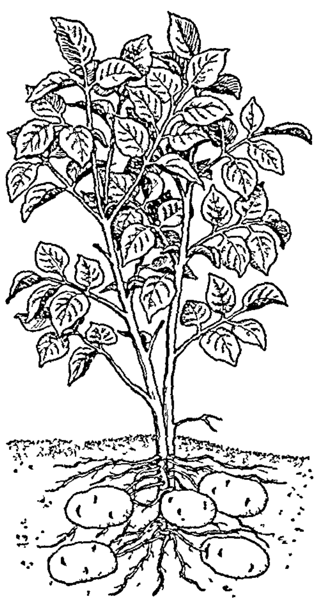
Potatoes as Food and Industrial Products

Boiling, frying, and baking are three common ways of preparing potatoes for eating. A new industry sells already peeled potatoes to housewives and restaurant owners. Potatoes are also made into flour.

A potato is made up of about three-fourths water. This can be removed (dehydrated) in order to save valuable shipping space and weight; dehydrated potatoes readily take up water again when prepared as a food. Potato chips are sold in cans and bags. Small potatoes are cooked and canned. French fried potatoes and mashed potato mix are sold as frozen foods. (*See also* Food.)

About a fifth of a potato is carbohydrate, or starch. Potato starch was in common household use for many years but now has been largely replaced by cornstarch. Potato starch, however, has other uses.

It is used as a coating, or *sizing*, on both paper and textiles (*see* Paper; Textiles). Dextrin, made from potato starch, is used as a paste and as a coating for photographic film. Potato starch also can be converted into the industrially valuable ethyl and butyl alcohols.



ONE OF THE MOST VALUABLE FOOD PLANTS

The potato plant stores up carbohydrates in underground tubers. When the leaves wither the tubers are ready for harvest. Pieces of tubers with "eyes" are planted. New varieties result when seeds are planted. A ball that sometimes develops from the blossom contains the seed.

Where Potatoes Grow

Potatoes thrive in areas that are slightly too cool for growing corn. Much of Europe and the Soviet Union are good potato-growing regions. In America the best growing areas extend south from Newfoundland through the Canadian Maritime Provinces into the New England states and through New York into Pennsylvania. The Great Lakes regions of both Canada and the United States are good growing areas. In the West the best production areas include Colorado, Idaho, Montana, and California. Some potatoes are grown in every state of the Union.

The United States grows almost 500 million bushels of potatoes a year, about 5 per cent of the world's crop. Canada grows about 90 million bushels, about one per cent of the world production. The countries of the Far East grow fewer potatoes because of climatic conditions and because rice has more food value than potatoes. Japan, grows about the same number of bushels as Canada. The 11 states listed in the table are the largest potato growers in the United States. The 11 countries are among the world's largest producers.

Percentage of U.S. Crop by States	
Maine	14
California	9
Idaho	9
New York	7
Colorado	4
North Dakota	4
Pennsylvania	3¾
Minnesota	3½
Michigan	3½
New Jersey	2½
Wisconsin	2½

Percentage of World Crop by Countries	
Soviet Union	33
Germany	15
Poland	11
France	7½
United Kingdom	5
Czechoslovakia	2⅔
Netherlands	2½
Ireland	1½
Italy	1
Spain	1
Denmark	1

How Potatoes Are Grown

The United States plants almost 2 million acres of potatoes. The average yield per acre is about 211 bushels, but especially suitable land has produced more than 1,000 bushels to the acre. Because of increased yields and because Americans now eat fewer potatoes, the United States plants less land to potatoes than it formerly did.

The Southern States plant potatoes late in winter. Harvested in the spring, these "early" potatoes are sold in the North at good prices. Another group of states, notably New Jersey, Virginia, Missouri, and Kentucky, plant potatoes in the spring and harvest them in the summer. The largest crop, "late" potatoes, is planted in May or June and is harvested in late September and October. The greatest potato-growing region of the United States is Aroostook County, Me.

Potatoes grow best in pulverized, heavily fertilized, and well-watered soils. Some fields are irrigated and all are cultivated frequently. Potatoes will not sprout until two months after harvest. Thereafter they must be stored in a cool place or treated with a sprout inhibitor.

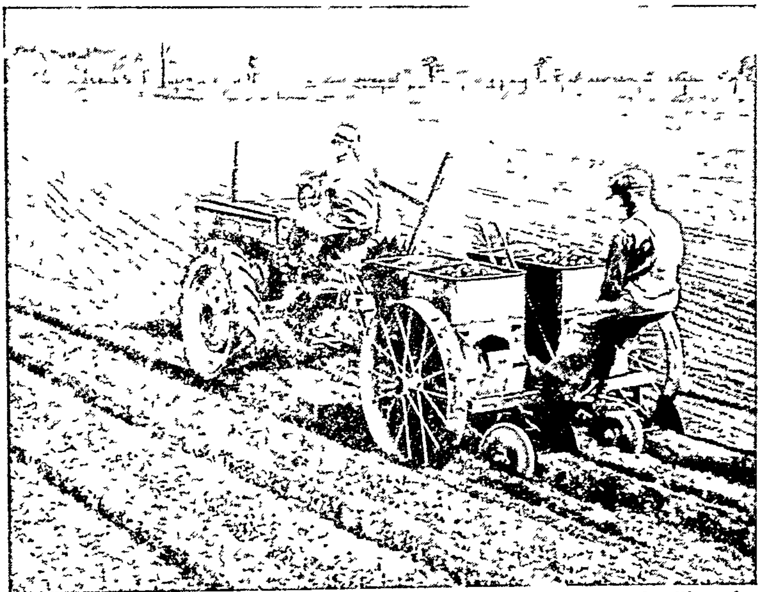
The Potato Plant

The potato, sometimes called "white" or "Irish" potato, is a member of the nightshade (*Solanceae*) family. This family includes the useful tomato and tobacco plants, the decorative petunia, and the poisonous belladonna plants. The potato (scientific name, *Solanum tuberosum*) is not related to the sweet potato (*see* Sweet Potato).

The potato flower is small and wheel-shaped and of either purplish or whitish hue. The flower sometimes develops into a soft green, seed-filled berry. These seeds are planted only by agricultural scientists who try to discover new varieties, as Burbank did in developing the potato that bears his name (*see* Burbank). The potato itself, or *tuber*, is an organ that grows at the end of an underground stem. It is the storage place for the plant's food. Potatoes used as seed are cut (to about the size of an egg) so that each piece has one or two eyes. The potato's eyes (small indentations) sprout and grow new plants.

At the time of the American Revolution there were only two varieties of potatoes: red and white. There now are about a thousand varieties. The best known of these are: Katahdin, Triumph, Cobbler, Chippewa, White Rose, Russet Burbank, and Green Mountain.

HOW THE POTATO FARMER PLANTS HIS CROP



The tractor pulls a two-row planter. The front hoppers drop fertilizer in furrows opened on both sides of the two rows. Between each pair of furrows the planter cuts a trench into which seed potatoes drop from the back hoppers. Disks at the rear then cover the fertilizer and seed.

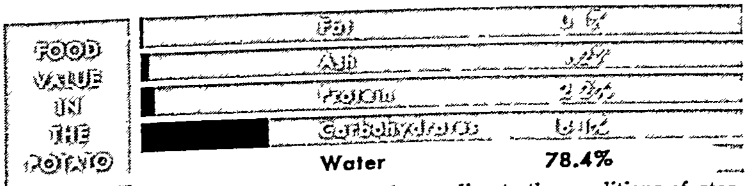
How Healthy Seed Potatoes Are Obtained

In the United States to ensure seed hardy and free of disease, potatoes for seed are grown under government supervision. These are sold as "certified seed." Most of the certified seed potatoes are grown in Maine, North Dakota, Minnesota, California, Wisconsin, Colorado, and Idaho.

The enemies of potatoes include such fungi diseases as early blight, rot, late blight, scab, and wilt; bacterial and virus diseases; and feeding worms and insects. A deadly enemy is the Colorado potato beetle, more commonly called the potato bug (*see* Potato Bug; Spraying and Fumigating).

Migration of the Potato

When the Spanish conquerors reached the Peruvian Andes in the early 1500's they found the Incas growing potatoes. The Indians called potatoes *papa*, but because in appearance it was similar to the sweet potato grown in the West Indies, the Spaniards called it *patata*. The English changed this to potato. No one knows who took the first potatoes to Europe, but it seems certain that they had reached Spain by 1570.



Because values vary with the season and according to the conditions of storage, the percentages given here are approximate. (See the article on Food.)

Europeans did not know the food value of the potato, and for long they were grown only as a new and interesting plant. They were taken from Spain to Italy and from there to Austria and Germany. It is

probable that they reached England before 1590. In 1613 potatoes were shipped from England to Bermuda, and in 1621 from Bermuda to Virginia.

By 1688 potatoes had become the food staple of the Irish. A scientist named Antoine-Augustin Parmentier dispelled the beliefs of French peasants that potatoes caused leprosy and fevers by writing (between 1773 and 1789) a series of books and pamphlets in which he urged potato cultivation. King Louis XVI helped to popularize them by wearing potato flowers in the buttonhole of his coat. Frederick the Great of Prussia ordered his subjects to plant potatoes as food for themselves and their cattle.

POTATO BUG. Civilization is responsible for the bad habits of this member of the beetle family. Five years before the Civil War, this insect was a harmless denizen of the western plains, where it fed on a weed called the sand bur or buffalo bur. Its only name in those days was its scientific one, *Dorophora decemlineata*, the absence of a common name proving that it had never bothered anyone very much.

Unfortunately, the sand bur was a sort of "country cousin" of the potato, and when the pioneer farmers of the West began planting potatoes, Dorophora discovered that the potato plant had a far more delicate flavor than its wild relative. Abandoning the sandbur of the dry plains, the insect invaded fields and gardens. The new food agreed with it so that it multiplied with startling rapidity, soon winning the title of "potato bug" or, more properly, "Colorado potato beetle."

Vast armies of these beetles began an eastward march. In 1859 they had reached Nebraska; in 1861 they were in Iowa; they crossed Iowa in four years; and jumped the Mississippi River in 1865. "They passed through Illinois," said one scientific observer, "traveling in many separate columns, just as Sherman marched to the sea."

By 1874 the potato beetle had reached the Atlantic seaboard, spreading north into Canada and south through Virginia. Today its territory includes all the United States east of the Rockies, with the exception of narrow strips along the Gulf of Mexico. It also found its way to Europe.

The adult potato bug is a yellowish-brown beetle about three-eighths of an inch long and one-quarter of an inch wide, with ten black stripes running lengthwise down its high rounded back. It spends the winter in the ground, coming out at the first thaw and waiting for the appearance of the first potato sprouts, which it attacks with starving appetite. It begins to lay its orange-colored eggs almost immediately, on the under side of the young leaves. They hatch in about a week, producing dark red larvae or "slugs" of a shiny and disgusting appearance, which begin at once to devour the leaves at a great rate. In about 20 days the larvae reach full size, enter the pupa stage in the ground, and emerge as adult beetles about two weeks later. As each female lays 1,000 eggs or more and there are from two to three generations a summer, it is easy to see how the potato bugs reach such enormous numbers. When potato plants are not available, they will often attack tomato plants, egg-plant, or even tobacco.

With proper care, the ravages of potato bugs are not hard to check. Formerly these beetles and their slugs were picked or brushed off the vines by hand, but today the system of spraying the leaves with paris green or some other arsenic compound has proved the most rapid and effective way.

Just as the potato bugs learned to eat potato vines, so many insects, birds, and other animals have learned to eat the potato bug, since it migrated from the West. Certain species of lady-bugs devour the eggs and the young larvae in large numbers; while ground beetles, tiger beetles, soldier bugs, robberflies, and spiders also give man assistance in the battle. The chief bird enemies of the potato bug are the grosbeaks, quail, robins, crows, grouse, and thrushes. The name "potato bug" is sometimes given to a three-striped leaf beetle and to some blister beetles. The scientific name of the true potato bug has been changed to *Leptinotarsa decemlineata.*

POTOMAC RIVER. Placid and deliberate, bearing fortunes in weighty commodities—naval ordnance, building and paving stones, sand and gravel, oils and ice—the broad Potomac from Washington to Chesapeake Bay forgets its birth in the mountains. Perhaps too it forgets the old days when the white men first came—Capt. John Smith seeking a passage to the South Sea; later, merchant vessels from London bearing goods and gauds of all kinds to offer Virginia and Maryland planters for the strange new-fangled commodity, tobacco; still later, the great barge of young Mr. George Washington putting out from the Virginia shore to visit the Calverts in Maryland; and then all the tragedy of the war between North and South, whose boundary line was the same river.

From its sources in the Alleghenies of Virginia and West Virginia to its mouth, the Potomac is about 450 miles long and for nearly its whole course a boundary between Maryland and West Virginia and Virginia. Its two branches, the north and the south, unite in Hampshire County, W. Va. From this junction to its mouth the river is 287 miles long. At Harpers Ferry the Shenandoah joins it in breaking a splendid gorge through the Blue Ridge. Later its other important tributary, the Monocacy, flows in from the Maryland side. Lower down, at the Great Falls, it tumbles over a six-staged terrace, once one of the wonders of America before Niagara Falls was easy to reach. The head of navigation is at Little Falls. At Washington, three and one-half miles farther down, the river is a mile wide, with a channel 20 feet deep. It is over seven miles wide where it enters Chesapeake Bay. The most important cities along its banks are Washington and Alexandria, Va., six miles southwest of the capital. Washington's home and tomb at Mount Vernon and the national cemetery at Arlington are among the places of interest along the river.

The Fine ART *of* POTTERY *and* PORCELAIN

1. German hard-paste porcelain, Meissen, Böttger, about 1720.
2. English soft-paste porcelain, Chelsea "goat and bee" jug, about 1745.

3. French soft-paste porcelain, tin glazed with Kakiemon decoration, Chantilly, about 1735. 4. English soft-paste porcelain, Chelsea silver-shaped dish, about 1755.

5. English soft-paste porcelain, probably from Derby, about 1755.
6. English soft-paste porcelain Father Time, Bow, about 1760.

POTTERY AND PORCELAIN. The craft of ceramics, or making clay vessels, is one of the oldest arts in the world. *Ceramics* comes from the Greek "keramos," meaning "earthenware," and refers to both the clay material and the potter's product. It usually means pottery and porcelain, both useful and ornamental. Ceramics includes not only the plates and dishes called "china" but also such diverse objects as beautiful ornamental figures and vases, utilitarian sewer pipes and sanitary fixtures, brick, tile, and massive insulators for electric power lines.

Pottery is a general term often applied to all products of the potter's art. Used more precisely, it is confined to wares with a rather soft clay body and fired at a comparatively low temperature. These are also called *earthenware.* A denser, harder pottery fired at a higher temperature is called *stoneware.* The use of vessels crudely shaped of clay and dried by the sun began before written history. Fragments of pottery found in excavations in Egypt are estimated to be more than 13,000 years old.

Porcelain, from the Italian "porcella" (meaning "little pig," a name given to a smooth, white cowrie shell), was developed much later. The first known specimens of true porcelain were made in China in the 6th century A.D. The term "porcelain" appears in the writings of Marco Polo, who visited China in the 13th century.

Porcelain, unlike pottery, is translucent. A strong light shining near the plate can be seen through it. The unglazed body, or basic structure, of pottery, whether it is earthenware, stoneware, or porcelain, is known as *biscuit.*

When and where the potter's wheel originated is unknown. In very early times it was used in Egypt, Persia, and Babylonia. Excavations in Egyptian tombs show that pottery making was well advanced as early as 3000 B.C. These clay objects, both useful and ornamental, give a good insight into the lives of these ancient peoples. Bottles, jars, and jugs for carrying and storing water represent a large portion of the earthenware vessels of the Egyptians. Many types of ornamental pottery were made for the kings and nobles. Even beads and other jewelry were made of clay. The earliest Egyptian pottery was a red earthenware, usually unglazed.

The Assyrians and Babylonians excelled in making bricks and tiles with lustrous glazes, often decorated in several colors called *polychrome* decorations. This art was further developed by the Persians, who made beautiful vases and adorned their palaces with brilliantly decorated tiles set in patterns called *arabesques.* The Persians originated a deep blue coloring matter used to decorate pottery, known later as "Mohammedan blue." This was imported by Chinese potters and used to decorate some of the magnificent porcelain made during the Ming Dynasty (1368-1644).

The ancient Greeks and Romans reflected their advanced civilizations in their pottery. The early

DR. WALL'S FAMOUS PORCELAIN

English soft-paste porcelain, Dr. Wall Worcester teapot from the Bodenham service, about 1760.

Greeks showed their love of purity of form and precise detail in their useful and ornamental wares. Their classic shapes of vases, urns, and bowls have changed little to the present day. The Greeks developed pottery making to its greatest art between the 6th and 4th centuries B.C. They portrayed their gods and heroes on vases beautiful in form but made of coarse clay.

The Greeks made good use of *slip* as a decoration. Slip is clay of one color applied to a clay body of a contrasting color. The principal colors were a brick red, black, and buff. In using slip, the red-on-black ware was decorated first by outlining the decoration on the red clay body. Then the background was filled in with a thin glaze of black, leaving the figures in red. The Greeks made charming small terra-cotta figures, known as Tanagra figurines, probably for use as ornaments or as children's toys.

The Romans, in building their massive structures, used fired bricks, often decorated with colored glazes. Their pottery included a red earthenware known as Samian ware and a black pottery known as Etruscan ware. This should not be confused with pottery actually made by the Etruscans in an earlier era (*see* Etruscans). Examples of Roman pottery have been unearthed in Britain and in other countries occupied by the Romans. The Romans probably pioneered in the use of ceramic drain pipes, bathtubs, and similar useful articles.

Chinese Pottery and Porcelain

In China the potter's workmanship was lifted above the utilitarian level and became a fine art. The great work of the imperial potters at the peak of their excellence has never been equaled in modern times.

Pottery was made in China long before history was set down in writing. A coarse gray earthenware was made before the Shang Dynasty (about 1700–1100 B.C.), and a finer white pottery was made during this era. These vessels resemble in size and shape the Chinese bronze vessels of the same period, and it is likely that the bronzes were first copied from pottery.

It is from the Han Dynasty (206 B.C.–A.D. 220) that the history of pottery making in China is ordinarily traced. The ancient Chinese had a custom of burying with the dead pottery images of people, animals, and possessions dear to them during life. These images have given modern students a clear insight into the life and customs of these people which would otherwise be lost.

The period of the Six Dynasties (A.D. 220–587) is noted for vigorous modeling of figures, particularly of animals. The beautiful pottery horses of the T'ang Dynasty (A.D. 618–906) are among the most celebrated examples of ancient Chinese art. Glaze was probably first used on the earthenware body in the Han Dynasty. By the time of the Sung Dynasty (A.D. 960–1279) pottery of simple design was decorated with beautiful monochrome glazes. *Celadon,* or sea green, is probably the best known of these glazes.

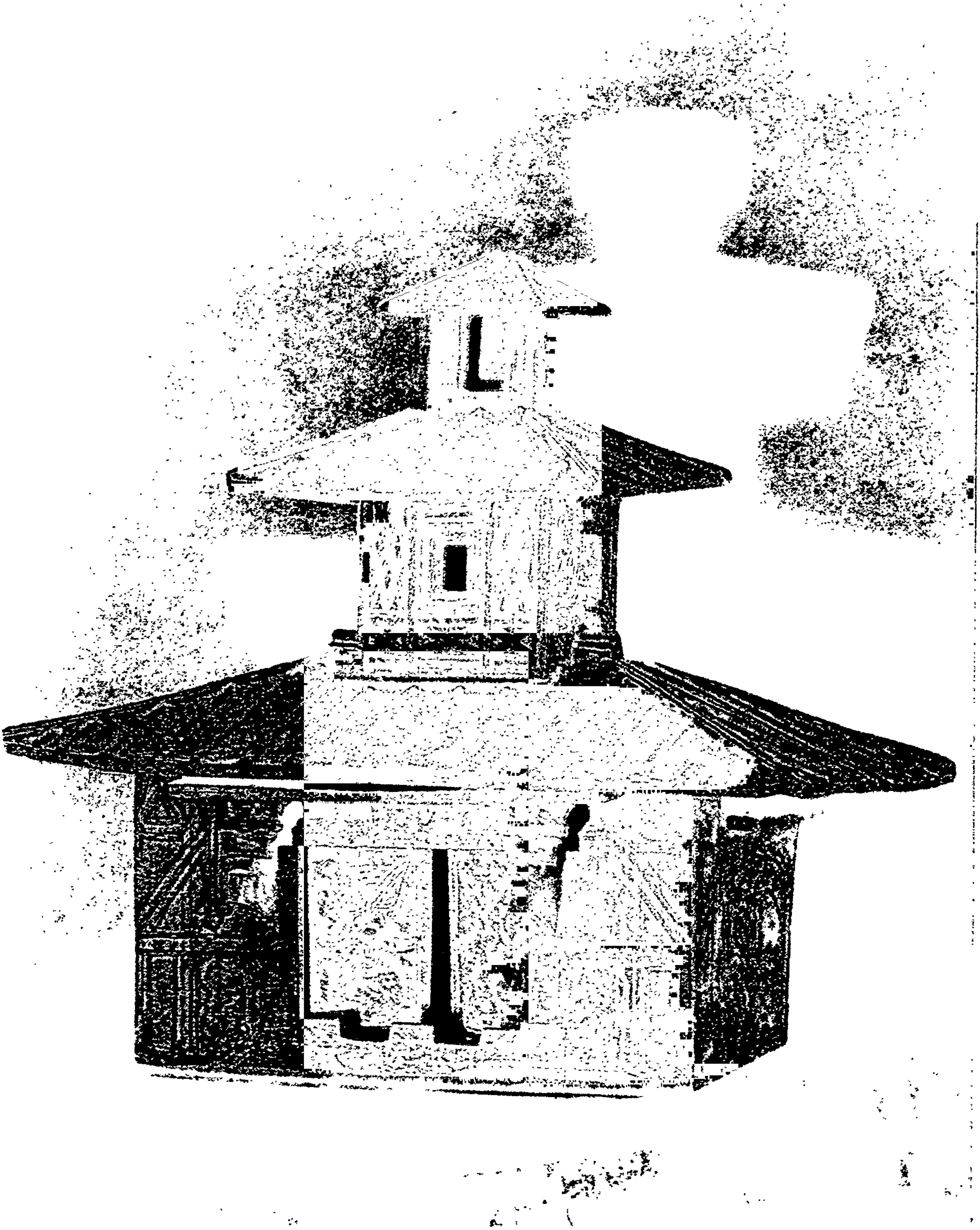
Although crazed, or crackled, glazes appear to have been used before the Sung Dynasty, they are commonly associated with this period. This shrinking and cracking of the glaze, due to too rapid cooling, was probably first an accident of firing. The resulting effects were so attractive that crackled glazes became a studied effect in the finer wares.

Porcelain was gradually evolved in China, probably during the T'ang Dynasty. It grew out of earthenware by a process of refining materials and manufacturing techniques. This true porcelain, sometimes called *hard-paste* porcelain, was a combination of *kaolin,* or China clay, and *petuntse,* also known as feldspar or China stone. These ingredients were called by the Chinese the *body* and the *bone* of the porcelain.

The principal porcelain factory in China was the imperial plant at Ching-te-Chen (now Fowliang) in Kiangsi Province. Pottery and porcelain probably were made there long before Ching-te-Chen became the seat of the imperial potteries under Emperor Chen Tsung about A.D. 1004. The Jesuit missionary, Père d'Entrecolles, later described the city and the art of porcelain making in two letters written in China

ANCIENT AND BEAUTIFUL GREEK POTTERY

The Greek pottery drinking cup, or *cylix* (left), in red on black, showing Artemis with a torch, is ascribed to Douris of Athens and is dated about 450 B.C. The Greek pottery water jar, or *hydria* (right), showing a girl embracing an athlete, is dated 480–460 B.C.



CHINESE POTTERY, TWO THOUSAND YEARS OLD

This porcelain house, about two feet high, was dug from a grave of the Han Dynasty (200 B.C. to A.D. 220). It was buried 2,000 years ago with the head of the Chinese family so that his spirit would be sheltered, comforted, and entertained as happily as in his lifetime. The paintings on the outside walls and doors include large tiger heads. Probably they represented protective spirits. The doors, set on pin-and-socket hinges, swing inward.

GRACEFUL VASES OF THE K'ANG HSI PERIOD

When first brought from the Far East in the 17th century, vases such as these were called "chinaware" in tribute to their source. This fine porcelain reached perfection under Emperor K'ang Hsi (1662–1722). The top vase has a "peach bloom" glaze, like the color of a ripening peach. The gray-blue glaze on the center vase is called "clair de lune" (French for "moonlight"). The crackled surface of the bottom vase is not the result of age. It was produced deliberately when the vase was made. The pottery illustrated on these two pages is from the Lucy Maud Buckingham Collection in the Art Institute of Chicago.

in 1712 and 1722. These brought to Europe the first detailed account of Chinese porcelain manufacture. He described the great porcelain-making center as holding a million people and 3,000 kilns, with its great fires against the night sky giving it the appearance of a burning city.

The magnificent glazes and decorations made at the imperial factory were intended to reproduce beautiful natural colors. Some of the best known glazes are *celadon; peach bloom*, like the skin of a ripening peach; *apple green; sang de boeuf*, or oxblood; and *clair de lune*, a pale gray blue resembling soft moonlight. The beautiful decoration called *cracked ice* is said to have been inspired by the reflection of sunny blue sky in the ice of a stream cracking with the first spring thaw. The *rice-grain* decoration was achieved by cutting out the decoration from the porcelain body before glazing. The glaze then filled the cutout portions which remained transparent after firing. *Famille rose* (rose or soft pink), *famille verte* (green), and *famille noir* (black) are decorations in which these colors are dominant.

The porcelains of the Ming Dynasty (1368–1644) were noted for boldness in form and decoration, with great variations in design. They include the handsome blue and white wares, huge and heavy vessels for the imperial temples, and thin and delicate white eggshell porcelain. Great beauty in polychrome decoration was attained in the later Ch'ing, or Manchu, Dynasty (1644–1912), particularly in the reign of Emperor K'ang Hsi (1662–1722).

Some fine white porcelain was made at Te-hua in the province of Fukien in South China from the 1400's to the 1700's. Some of this ware was brought to Europe by early traders, where it was known as *blanc de chine*. It provided many models for the early European porcelain makers.

During a rebellion in 1853 the imperial factory was burned. The rebels sacked the town, killing some potters and scattering others. The factory was rebuilt in 1864 but never regained its former excellence. With the end of the Manchu Dynasty in 1912, the long history of Chinese porcelain making drew to a close.

Korean Pottery

A very fine pottery was made in Korea from early times. These early wares were mainly of a slaty gray color. The art of pottery making was well advanced by the beginning of the Koryu (Korai or Koryo) Dynasty (A.D. 918-1392). This period is noted for a fine celadon ware with incised and inlaid decoration.

The Koryu Dynasty ended with a revolt led by General Yi Songgye (later called Yi Taijo). The succeeding dynasty which bears his name lasted until 1910. The decline of Korean culture after the Koryu Dynasty was reflected in both the quality and the decoration of its pottery. However, some of the rough and primitive looking Yi wares have charm. Porcelain was made in Korea in the 1700's and 1800's.

Japanese Pottery and Porcelain

Both pottery and porcelain developed considerably later in Japan than in China or Korea. The dolmen people, invaders from the mainland of Asia who inhabited Japan from the 3d century B.C. to the 7th century A.D., used primitive pottery vessels. Much early Japanese pottery resembles the Korean wares of the same period.

In the 13th century the development of the tea ceremony as an important part of Japanese life gave impetus to the potter's art. A Japanese potter, Shirozaemon, studied pottery-making methods in China. On his return he set up a factory at Seto.

At the end of the 16th century potters were imported from Korea. They settled in various parts of Japan, and potteries arose in scattered sections. Probably the best-known Japanese pottery is Satsuma ware, made since the 16th century. Satsuma is noted for a soft ivory-colored crackled glaze. Other important wares, named for the towns in which their potteries were located, are Karatsu, Hagi, Takatori, Yatsushiro, and Kioto (Kyoto).

In 1510 the Japanese potter Shonzui paid a visit to the Chinese imperial porcelain factory at Ching-te-Chen. He stayed perhaps as long as five years studying the art of porcelain making. On his return he brought back Chinese materials, including some of the fabulous Mohammedan blue coloring matter. He set up business near Arita and made porcelain until his stock of Chinese materials ran out. Later both China stone and China clay were found in Japan. In the 17th and 18th centuries many factories sprang up, making a very fine quality of porcelain. Best known among these are Arita, Nabeshima, and Kutani wares.

The Japanese style of porcelain decoration had a greater influence on European taste and styles than even the Chinese. Later on, Chinese decoration itself was influenced by the Japanese style. Most important was the delicate work of the potter Kakiemon. His spare and stylized paintings on porcelains of a few blossoms or a flowering tree, with a bird or a legendary animal, were copied by the Germans, French, and English. These nations were captivated by the Japanese porcelains imported by the Dutch traders. Another heavier decoration was the Imari, or brocade, pattern made for export. In modern times much good but inexpensive porcelain for home use has been made in Japan for the European and American markets.

European Pottery

No ceramic ware worthy of note was produced in Europe from the time of the Romans until about A.D. 712. Then the Moors crossed over from Africa into Spain and implanted their Mohammedan culture on southwestern Europe for a span of nearly 800 years. The beautiful creations of the Moorish potters in Spain, now called Hispano-Moresque, had a profound and lasting effect on European ceramic design. They made glazed tiles, such as those used to decorate the Alhambra at Granada, and large pottery jars and water vessels decorated in geometric and other abstract designs called *arabesques*. These were typical of the work of the Moorish potters just before and during the early Renaissance. Their work came to an end when

A MASTERPIECE BY AN ITALIAN POTTER

For centuries this Madonna and the angels looked down from the doorway of the Casa Tantini in Florence, Italy. It is now in the National Museum in Florence. The work is by Luca della Robbia, a Renaissance sculptor who turned potter and created many famous pieces. He and his nephew Andrea della Robbia produced the beautiful and now famous "Della Robbia ware."

the Moors were finally expelled from Spain by Philip III in the early 17th century.

In the 15th century the Italians began making a tin-glazed earthenware called *maiolica.* This was developed from Spanish wares imported from Majorca in the Balearic Islands. It was first manufactured at Valencia where green and purple decoration prevailed. Later the term maiolica was applied to all tin-glazed earthenware with brilliant polychrome decoration in blue, green, purple, orange, and yellow. Principal maiolica factories of the 16th, 17th, and 18th centuries were Faenza, Deruta, Castel Durante, Caffaggiolo, and Siena. Typical maiolica wares were large plaques and platters with beautifully executed religious scenes in brilliant colors.

The tin-glazed terra-cotta modeled objects of Luca della Robbia and of his nephew Andrea della Robbia were usually of religious themes. These products of 15th-century Italy are noted for beauty of brilliantly colored glazes and excellence of modeling. (*See also* Robbia.)

The importation of Chinese porcelain by Dutch traders began in the 17th century. Soon after, the Europeans began to imitate the prized Chinese porcelains in a fine tin-glazed earthenware. Some of it was actually made in the town of Delft. However, the term *delftware* has been applied generally to tin-glazed pottery, whether made in Holland, Germany, France, or England. Much of this ware was decorated in blue and white, copying the fine blue and white Chinese porcelain. Polychrome decorations in brilliant colors also copied the Chinese and Japanese styles.

The Dutch traders brought back crude red earthenware teapots with their tea imports. These were copied by Dutch potters and were the forerunners of similar ware made in England later in the 17th century by John Dwight of Fulham and the Elers brothers. A fine red stoneware made by Böttger in Germany was the immediate ancestor of true porcelain in Europe.

Much fine pottery known as *faïence* was made in France and Italy from the 16th to the 18th centuries. The extremely rare Henri II ware, the exquisite work of Bernard Palissy, the arabesque designs of Louis Poterat at Rouen, and the brilliant colored glazes of Paul Hannong at Strasbourg are particularly notable. Palissy, a potter at Saintes, France, in the 1500's, struggled for years to perfect a fine enamel on earthenware. He worked in a poverty so great that he was forced to burn his furniture and the flooring in his home to keep the fires going in his kiln. He lived to enjoy great fame and to have nobles pay huge prices for his works of ceramic art. Some of his works are grotesque low reliefs of reptiles, animals, and fishes on the surfaces of large dishes and ewers.

Pottery making in Europe probably reached its height, both artistic and utilitarian, in Staffordshire, England, in the 1600's and 1700's. Especially good were the stoneware figures and useful wares of John Dwight of Fulham, the Lambeth delftware, and the slip wares of Thomas and Ralph Toft and the Elers brothers in the 17th century. Examples of these wares are now rare museum pieces. They gave promise of the industry which has flourished in Staffordshire from the 1700's to the present time, exporting wares to all parts of the world. The blue and white china of the middle 1800's is mostly Staffordshire ware.

The term "Staffordshire" has come to be applied to the products of the numerous potteries (about 150 in

EARLY AMERICAN POTTERY

This is an example of Pennsylvania German pottery known as "tulip ware." It was manufactured in the early 19th century. Pottery such as this was made in imitation of German wares.

1800) which flourished in that area in the 18th and 19th centuries. These include the lovely mottled Whieldon ware; the amusing figures of Ralph Wood, father and son; many fine stonewares, including the early salt-glazed stoneware; and the noted cream-colored ware, jasper, basalt, and other wares of Josiah Wedgwood, the most famous potter of all time.

It was Wedgwood who first made fine quality tableware so cheaply that it was available for everyday use, both in England and overseas. His beautiful cream-colored ware, an earthenware body with a soft creamy glaze, also known as queen's ware, brought about a revolution in the ceramic industry. It made possible the mass production of wares which could be sold at very low prices. The revolution also brought a decline in the painstaking art handcraft of pottery.

Wedgwood made many beautiful ornamental vases, plaques, and other art works in a fine, unglazed pure-white stoneware known as jasper ware. This was often colored with metallic oxides on which figures and scenes were depicted in low relief, usually in white on a background of blue, green, brown, or black. Basalt was a fine textured stoneware, colored black by iron and manganese. Wedgwood's decorations were in the classic style made popular by the excavations at Pompeii, Italy.

Josiah Spode was another famous Staffordshire potter. He first worked for Whieldon, then started his own pottery in 1770. His son, Josiah Spode, is credited with introducing ironstone, or stone china, a dense hard earthenware containing feldspar.

European Porcelain

The beautiful and delicate porcelains of China and Japan were brought into Europe after the opening of trade with the Orient. They created such an intense fashion for fine porcelain with the ruling classes that it was called a "china mania." Kings vied with each other in attempts to discover the secret of true porcelain jealously guarded by the Orientals. The nobility were no longer satisfied with vessels of opaque earthenware, and even gold and silver services gave way to the more highly prized porcelains.

As early as 1580 Francesco de 'Medici had manufactured in Florence a ware with a translucent body called porcelain. This was not the true Chinese porcelain but a *soft-paste* porcelain made of various mixtures of white firing clay and glass, or "frit." The manufacture of this soft-paste porcelain spread through France, Italy, and England until it was finally displaced by true, or hard-paste, porcelain, whose secret of manufacture became known in Europe.

Augustus II, the Strong, elector of Saxony and king of Poland, wanted to make porcelain in Saxony and thus stop the spending of large sums for Chinese porcelains. He had in his employ a young alchemist, Johann Friedrich Bottger. Augustus became convinced that Bòttger might bring him great wealth if he knew or could find out the secret of turning base metals into gold. He had Bottger held as a virtual prisoner while he paid him for his work. When Bottger failed, the king's patience was exhausted. He had him imprisoned in a fortress at Meissen, near Dresden.

There in 1706 Count von Tschirnhaus, a Saxon nobleman, got the king's permission to have Bòttger help him. Bottger soon developed a red stoneware so hard it could only be cut on the jeweler's wheel. About this time a true kaolin, such as that used by the Chinese, was discovered in Saxony. In 1709 Bottger developed —independently of the Chinese—a true hard porcelain with this clay. From this discovery grew the great Meissen porcelain factory, often known as Dresden, which had an unbroken existence to World War II.

At first the valuable secret was guarded carefully at Meissen. In 1718 a runaway workman carried the formula to Vienna. There its manufacture flourished under a great manager, Claude du Paquier, who was responsible for much fine porcelain in the baroque style. Other factories for the manufacture of hard paste soon were sponsored by various German rulers. Among them were factories at Berlin, Hochst, Frankenthal, Nymphenburg, Ludwigsburg, and Furstenberg.

Modeling of porcelain figures became a fine art in 18th-century Germany. Of particular importance is the work of Johann Joachim Kandler at Meissen, Franz Anton Bustelli at Nymphenburg, and Johann Peter Melchior at Höchst. Bustelli figures rank with the most valuable of all ceramic art works. The little figures of children molded by Melchior are among the most delightful examples of the potter's art.

In the meantime soft-paste porcelain factories had sprung up in France, Italy, and England. Principal among the French factories were St. Cloud, Vincennes, Sèvres, Chantilly, and Mennecy-Villeroy. Vincennes and its successor Sèvres were under the personal patronage of the kings Louis XIV and Louis XV. Other

French porcelain factories were subsidized by lesser nobles. For a time none but the royal factory could make use of gold in decoration.

Madame de Pompadour was a patroness of the royal factory. For her the factory made beautiful and naturalistic porcelain flowers mounted on branches made of bronze. The story is told that one day she showed Louis XV some of these flowers in her hothouse and he mistook them for real ones. The magnificent and often ornate creations of the Vincennes and Sèvres workmen in soft-paste porcelain reflect the splendor of the French court of the rococo period. The Sèvres factory made hard-paste porcelain from 1769, when the secrets of its manufacture became known in France. It continued to make soft-paste porcelain until 1800.

In Italy soft-paste porcelain was made by the Doccia, Venice, Capo di Monte, and other factories. Capo di Monte was started in 1743 by Charles III, King of Naples. It was moved to Madrid in 1759 when Charles ascended the throne of Spain. There it was known as Buen Retiro. Genuine Capo di Monte porcelain is extremely rare. The ornate wares with designs in low relief falsely called Capo di Monte are poor imitations made in Italy and France from the 18th century until modern times.

Excellent hard-paste porcelain was made at Copenhagen, Denmark, during the last quarter of the 18th century. The royal factory executed the Flora Danica service for Catherine the Great of Russia. It was probably the most famous and most elaborate dinner service ever made. Work on it was started in 1789 and not finished until 1802. This service, numbering 1,602 pieces, was decorated exclusively with Danish botanical subjects. In the second half of the 18th century, both faïence and soft-paste porcelain were made at Marieberg, Sweden.

These continental factories were usually sponsored by kings and nobles. In England the development of porcelain was left to private enterprise. Probably the first English soft-paste porcelain factory was one founded at Chelsea about 1745. It grew to prominence under Nicholas Sprimont, a French silversmith. From its start until its close in 1769 the Chelsea factory, catering to the tastes of the nobility, produced some of the most valuable porcelains of all time.

Other factories, such as Bow, Derby, Longton Hall, and Lowestoft made both ornamental and useful wares. Many fine figures were made at Bow, Derby, and Longton Hall. Many figures of biscuit, or unglazed porcelain, were made at Derby in the late 1700's and in the 1800's. However, the best works in this medium were the beautiful soft-paste porcelain figures, groups, and busts done at Sèvres.

English Lowestoft is not to be confused with the vast amount of Chinese porcelain brought to America and England in the late 1700's and early 1800's. This is sometimes wrongly identified as Lowestoft. This porcelain, usually distinguishable by a grayish glaze, is properly known as "Chinese export porcelain."

Elaborate and handsome dinner services were made at the Worcester factory founded by Dr. John Wall in 1751. This factory also produced fine ornamental pieces. Vases and other objects of Worcester porcelain decorated by Jeffrey Hamet O'Neal and by John Donaldson are considered great works of the potter's art. The art of transfer printing on porcelain was discovered by Robert Hancock of Worcester. When utilitarian china was mass produced in the 1800's, hand decoration was displaced by transfer printing.

The soft-paste bodies made by these factories were impractical because of their inability to withstand extremes of heat and cold and because of the high waste caused by warping in the kilns. The first true porcelain factory in England was founded at Plymouth in 1768 by William Cookworthy. It was transferred to Bristol in 1770 by Richard Champion. Most of these makers of fine English porcelain remained in business but a few years and only one or two lasted beyond the end of the century. Some delicate soft-paste porcelain was made in Wales at Nantgarw and Swansea early in the 1800's. However, by this time porcelain had declined as a fine art, giving way to mass production.

Although bone ash had been used as a soft-paste porcelain ingredient at Bow many years before, Josiah Spode, the younger, developed the first English bone-china body. The firm of Copeland & Garrett succeeded to the pottery operated by three generations of Josiah Spodes. About 1845 it developed a body known as Parian porcelain which resembled white marble. It contained kaolin, feldspar, ball clay, and flint glass. This was an improvement on the old biscuit, or unglazed porcelain, for figure modeling. However, productions in Parian ware have little artistic merit.

A POTTER'S WHEEL

Shaping a piece of raw clay on a potter's wheel is one of the oldest phases of pottery making. It is still practiced today. Here a pottery hobbyist is deftly shaping a small bowl.

STEPS IN MANUFACTURING CHINA

1. A lump of the clay mixture is flattened out to form a "bat." Here the worker slaps the bat down over a plaster-of-Paris mold. 2. The mold with its bat is placed on a motor-driven potter's wheel. As the wheel spins, a tool shapes the upper side of the bat. 3. The ware goes through a tunnel kiln in containers called *saggers* for days of firing at temperatures rising to over 2,000°F.

Modern European pottery and porcelain is no longer a handcraft, except for some very expensive one-of-a-kind pieces. Nevertheless it has maintained a high standard of quality. The fine porcelains of the Copenhagen factories and the Belleek factory in Northern Ireland are especially noteworthy. Belleek ware is eggshell thin, with a highly translucent body and a soft, ivory-colored lustrous glaze. The Copenhagen factories and Nymphenburg and Rosenthal in Germany are noted for their excellent figure modeling.

Pottery and Porcelain in America

The first record of porcelain manufacture in America relates to the work of Andrew Duché, a Savannah potter. He made chinaware of clay found in Georgia in the 1740's. Duché sent some of this clay, called "unaker" by the Indians, to England. It was used at Bow as an ingredient of its soft-paste porcelain.

Most of the porcelain in the colonies was brought either directly from China or from China by way of England in sailing vessels. There was little to encourage local manufacture of pottery or porcelain. The Pennsylvania Germans made stoneware and a slip-decorated pottery in imitation of German wares. Some of this had *sgraffito* decorations. In this the red-clay body was dipped in colored slip and then designs were cut through the slip into the body of the ware.

Excellent pottery was made at Bennington, Vt., before the end of the 1700's. This pottery specialized in crudely shaped figures, jugs, and pitchers, often with a green and brown flint-enameled glaze. Tucker and Hemphill made a good quality porcelain ware in Philadelphia for several years after 1825.

In modern times huge commercial potteries have grown up in districts where suitable clay is found, particularly in eastern Ohio, West Virginia, and New Jersey. East Liverpool, Steubenville, and Zanesville, Ohio, and Trenton, N. J., have large ceramic industries. Many of these potteries specialize in a tough, completely vitrified ware for use in restaurants and hotels. Several modern American companies make fine-quality porcelain. One of the pioneer makers of fine porcelain was Walter Scott Lenox, who admired and imitated the thin ivory body and brilliant glaze of Irish Belleek porcelain.

Pottery and porcelain manufacturing in America today may be divided into (1) commercial mass production of utilitarian tablewares and other porcelain articles in homes and industries, (2) the art potteries producing decorative pieces such as lamps, figures, and vases, and (3) the small studio potters who have adapted modern design to the art of ceramics.

Los Angeles has become one of the most important ceramic centers in America. California earthenwares are noted for graceful modern design and pleasing decoration. Manufacturing ceramic tiles is an important industry in California.

The Manufacture of Pottery and Porcelain

The techniques of pottery and porcelain manufacture vary from ancient to modern times, from art works to utilitarian products, and from one country to another. The basic needs for making all ceramics are a raw material—clay for earthenware; kaolin, or China clay, and feldspar, or China stone, for porcelain—and a hot fire. The rest depends upon the potter's work.

The potter must first find the proper clay, then purify and cure it to make it usable. Raw clays or kaolins are washed in large vats called *blungers* to remove such foreign matter as pebbles, sand, and feldspar. These settle in the washing process; the clay remains in suspension in the water and is poured off. This washed clay is known as *slip*.

If the ware is to be made by using clay in a plastic state (not completely dry) the mixture of materials is forced through *pugmills* where it is cut up and compressed by rotating knives. Then it is forced out and formed into cakes or other convenient shapes for storage and handling. Completely dried clay is ground, sifted, then mixed with other ingredients in rotating mixing machines. Next it is moistened to give it sufficient plasticity. If the clay is kaolin for the manu-

MODERN AMERICAN MASS-PRODUCED CHINA

These pieces are examples of modern American semivitreous dinnerware. They are mass-produced by large companies, but they still retain the interest and charm of the old hand-wrought pieces. The set at the left is called "Skytone"; the set at the right is named "American Provincial." Note the humorous portraits of the old-time farmer and his wife in the set at the right.

facture of porcelain, it is combined with feldspar, white-burning ball clay, and flint or quartz. If the product is bone china, bone ash also is added.

The next step is forming the ceramic object. This may be done by "throwing" on a potter's wheel, by molding, or by casting. "Throwing" means shaping a mass of clay spinning on a potter's wheel, or circular revolving table. The clay is shaped by the moistened hands of the potter into vase, bowl, plate, or jug. The potter's wheel is particularly needed for making round objects, although flat round objects such as plates usually are made in molds.

In molding plates, a plaster mold forms the top surface of the object and a profile tool, called a *jigger*, forms the bottom. In molding cups, the outside is formed by the mold and the inside by the jigger.

In casting, a plaster mold made in sections is filled with liquid slip. This is later poured off, leaving a layer of slip on the mold's inner surfaces. After this layer hardens it is removed carefully. Slip casting is used for making articles of irregular or special shapes difficult to form by another method.

After the object is shaped, it is ready for firing. The intensity of firing depends on whether the object is pottery or porcelain and upon the kind of decoration. Earthenware may be fired at a temperature of 1,400° F.; porcelain or stoneware may need 2,700° F.

The object is fired in a kiln. This may be an open-hearth fire for baking crude clay bowls, the wood-fired kilns of 18th-century France and England, or the modern electrically fired tunnel ovens. Through the tunnel ovens, several hundred feet long, the wares of modern potteries pass slowly on a moving conveyer. The objects to be fired may be placed in fire-clay boxes, called *saggers*, arranged in tiers or piles. The saggers protect the ware from direct contact with the fire. Otherwise the objects are stacked in piles and separated by *stilts* of fire clay.

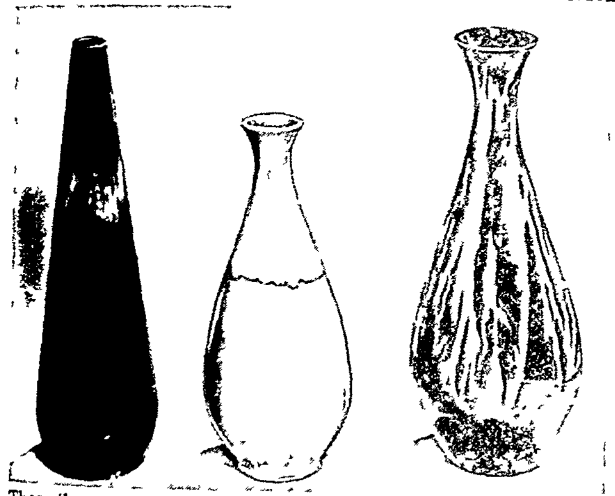
In China a porcelain object was dried in the air after it was shaped and before decoration or glaze was applied. If it was blue and white ware, the blue cobalt was painted on the air-dried body, the glaze was thinly applied, and the whole object finished with one firing at intense heat. The European soft-paste porcelain body was fired first at a fairly high temperature, then glazed and fired again at a lower temperature. Firing the body is called *bisque* firing; firing the glaze is called *glost* firing.

In underglaze decoration the design is painted on the body before firing if the piece is to be fired only once as in China. Otherwise it is painted on after the first firing and before the glazing and second firing. Overglaze decoration is painted on after

A STUDIO POTTER'S WORK

This modern American stoneware "branch bottle" was produced as a "one-of-a-kind" piece by a studio potter. In shape it resembles early American pieces; in decoration it is completely modern.

MODERN AMERICAN COMMERCIAL ARTWARE

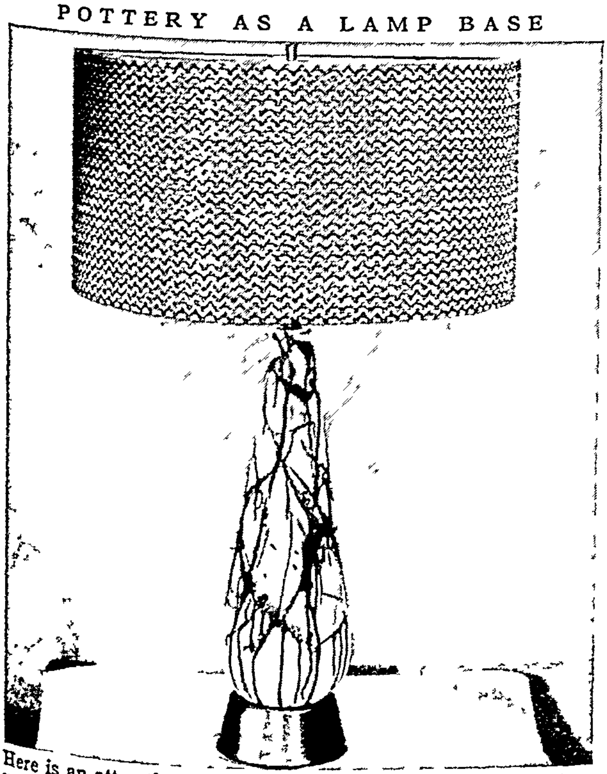


These three vases are interesting examples of modern American artware pottery. They are made by companies specializing in decorative pieces produced in fairly large numbers.

the glaze has been fired. It is then fixed to the glaze by another firing at a relatively low temperature.

Only the Chinese were completely successful in the use of underglaze decoration on hard-paste porcelain. Most European hard-paste porcelain is decorated overglaze. Even in China only a few colors were used successfully to decorate underglaze. Among these were cobalt blue and reds derived from copper. A full range of colors may be used in decorating overglaze. In 18th-century soft-paste porcelain, the overglaze decoration fused with the glaze. Glaze and decoration formed a whole, and the soft effect is pleasing.

POTTERY AS A LAMP BASE



Here is an attractive piece of modern American pottery being used as a base for a lamp. It is also an example of an adaptation of hand-wrought beauty to commercial manufacture.

Most modern underglaze decorated chinaware is decorated by the transfer print, or decalcomania, process. In this, colored tissue paper prints are applied to the unglazed ware. When the tissues are soaked off, the design remains.

There are many kinds of glazes. The Chinese used a feldspathic glaze consisting of kaolin with a little lime and potash added. Modern liquid glazes are composed of such materials as feldspar, ground quartz, or silica, boric acid, and lead oxide. Although glazes ordinarily are transparent, adding tin oxide to a lead glaze produces an opaque white glaze characteristic of maiolica, faience, and delftware. Salt glaze on stoneware was achieved by throwing salt into the kiln during firing. Colored glazes were produced by introducing iron oxide for green or gray-green, ferric oxide for yellows and browns, and copper for red.

Hints to Collectors

The new collector in any field of pottery or porcelain is entering a vast and fascinating new world. He will see much that he does not understand. He should start by making a thorough study of the type of ceramic art which most interests him. He should read all available books and make frequent trips to museums. Thus he will save himself many mistakes which in the collection of rare antiques may be costly ones. Above all, he should touch and examine as many pieces as possible. One cannot get the "feel" of porcelain by looking at it in a glass case, although form and decoration may be studied in this way.

The new collector should be restrained and selective in making purchases. He should buy only what appeals to his sense of beauty and knowledge of authenticity. He will rely upon his own judgment, based upon examination of body and glaze, rather than upon marks or statements of dealers, who often may know less than he does about the particular object. Marks should be relied on only to support a determination of authenticity from examination of the piece itself.

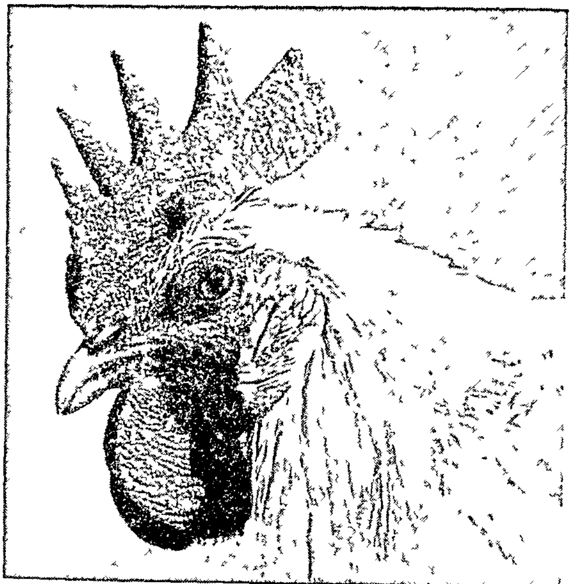
In China fine porcelains of one dynasty, or reign, were copied in a later one, complete with the earlier marks. The Chinese believed that only in this way did they make a true copy. In Europe, however, marks have been faked with deliberate intent to deceive. There has existed in Paris for many years a large pottery engaged in copying collectors' items of German, French, and English porcelain. Only study and experience will enable the novice to detect these deceptions.

In recent years the use of ultraviolet light has proved valuable in detecting repairs, restorations, and fakes. Experiments are being made with it to determine factories, and periods within factories, in the field of soft-paste porcelain.

Price depends largely on rarity. A representative piece may be purchased for a relatively small sum. If he can afford it, the collector should strive to acquire only perfect, or "mint," pieces. If he must confine himself to a modest investment, he can find much pleasure in studying the form, body, glaze, and decoration of an imperfect or repaired piece.

The BIRDS *That Hatch a* GIANT INDUSTRY

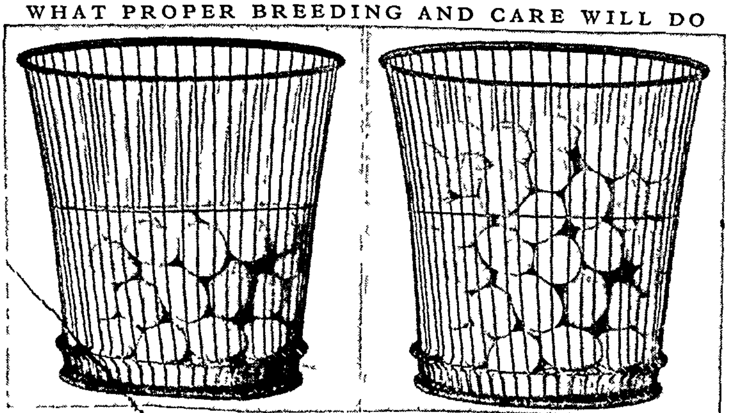
POULTRY. Every year the American hen more than pays for the cost of three Panama Canals. The value of poultry products in the United States normally exceeds that of the wheat crop and all but a small proportion of this comes from the common domestic fowl, or chicken. More than half of this surprising sum is the value of the eggs produced. The hen's egg is the only one of commercial importance, for practically all the eggs of other domestic fowls are used for hatching. Chickens also are far in the lead as meat producers. Of every 1,000 of the fowls available for marketing, about 940 are chickens, 40 are turkeys, and 17 are ducks.



The rooster is celebrated in drama and fable as "king of the barnyard." *This* white Leghorn looks the part, with its sharp eye, arrogant air, and erect crownlike comb.

Specialized poultry farms are operated on a larger scale in the United States than anywhere else, yet three-quarters of the country's chickens and eggs are by-products of general farming. Their quality has often been mediocre, since the farmer is not always able to give his flocks the same attention as he gives his main crops. In recent decades commercial firms as well as cooperative marketing associations have raised standards by paying premium prices for eggs and fowls of good quality. Cooperative associations in Denmark pioneered in these improved marketing methods. They stamped every egg with an identifying mark and held each producer responsible for the quality of his output.

WHAT PROPER BREEDING AND CARE WILL DO



A scrub hen will lay each year about 80 eggs—the number in the left-hand basket. With proper breeding, care, and feeding, a hen should average 150 eggs a year. The basket on the right shows what this increase means.

About 700 million chickens a year are raised on the farms of the United States. This does not include the millions from backyard coops which are not reported in the census returns. Chicken meat ranks third, next to pork and beef, as a source of food. More than two billion pounds are marketed in a year in addition to millions of pounds consumed on the farms. Millions of pounds of dressed poultry and eggs are placed in cold storage to insure a constant supply, especially during the winter months.

About 350 million hens are kept to produce eggs. In peak years they lay about 60 billion eggs. Under the modern system of separating the roosters from the hens at the close of the breeding season, infertile eggs are produced which will keep a longer time. In the home, eggs can be preserved by putting them in water glass (sodium silicate). Commercially, great quantities are preserved for months in cold storage. For baking and other industrial uses they may be frozen, or dehydrated and powdered.

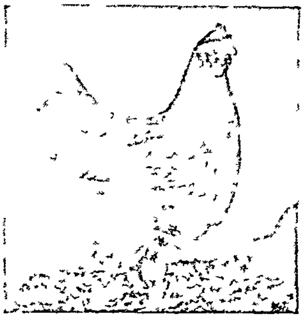
Cock Crows at the Dawn of History

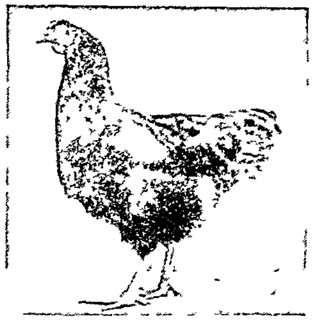
No one knows when chickens were first domesticated. Scientists believe that the wild fowls from which our tame breeds originated were natives of southwestern Asia, and that one of the species which contributed most largely to its ancestry is represented today by the red jungle fowl of India. This wild fowl is smaller than a prairie chicken (about two pounds), while a specimen of one of our meat varieties ready for the market sometimes weighs as much as 16 or 17 pounds. This is one of the many striking examples of what selective breeding will accomplish. Similarly, while the wild fowl lays only one small setting of eggs a year, a flock of good layers today will average 150 a year. Individual hens have reached a mark well over 350, and the 200-egg-a-year hen is quite common. Improvement in weight of meat and number of eggs produced in any flock may be brought about by using only the best specimens for breeding, by keeping the poultry house clean and well aired, and by providing plenty of clean water and good feed, selected in proper variety for a balanced ration. The trap nest system, which enables the poultryman to keep an accurate egg-laying record of each hen, is a great aid in improving a flock for egg production.

IMPORTANT BREEDS OF POULTRY


Plymouth Rock


Wyandotte


Orpington


Rhode Island Red

The poor layers can be eliminated and the eggs for setting selected only from the layers with the highest records.

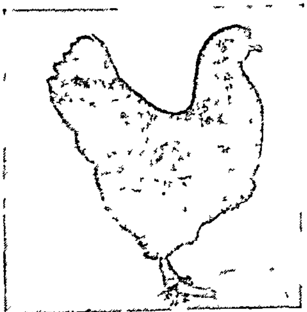
The hen seldom exercises the art of the wild fowl in making her own nest for her eggs, but occasionally one desiring to set will steal away to a hidden nest and lay her one egg a day until there are as many in the nest as her feathers will cover. She will then patiently keep them warm with the heat of her body for 20 to 21 days and bring off her little brood of downy chicks.

How the Little Chicks Go to School

A mother hen exhibits a highly developed instinct in caring for her family. She teaches them by patient example how to drink, how and what to eat, and calls them with special fervor to enjoy a worm or tempting bug. If danger threatens, her prompt warning clucks make them hide under the nearest cover. When their age-old enemy the hawk sails overhead, his fleeting shadow on the ground is spied by some watchful chicken, and a warning squawk goes up that sends even the grown-up members of the flock hurrying to cover.

The time of setting and of caring for a brood is so much time lost from laying, since the hen does not begin laying again until the young chickens are well able to care for themselves. For this reason, in a flock of any size, setting is discouraged. The hens that show a desire to set by staying on the nest, and clucking while off the nest, are cooped up until the impulse dies down.

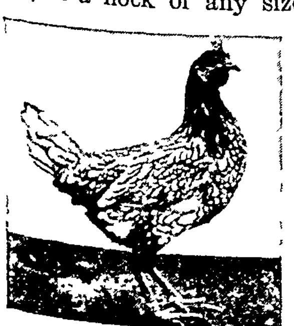

Cochin


Langshan

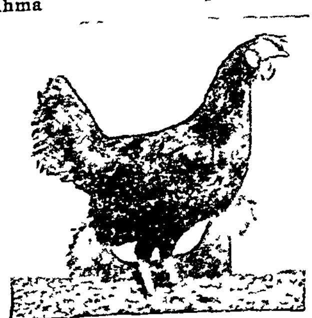

Brahma

In place of the setting hens, with their tiny broods, large incubators today hatch eggs by the thousands. Artificial incubation is not a new practise, for the ancient Egyptians hatched eggs by putting them in large brick ovens which held an even heat.

The modern incubator is planned to imitate the natural conditions for hatching. A warm even temperature is provided, with a supply of fresh and slightly moist air. Since a setting hen carefully turns each egg over from time to time, so likewise the eggs in the incubator are turned over frequently from the third to the eighth day. At the end of one week the eggs are tested and the infertile eggs, those which are not going to hatch, are removed. The test is made by the process known as "candling." The eggs are held before a light, and the infertile eggs appear clear and translucent. At the end of 14 days a second test is made to weed out those in which the germ has died. Finally at the end of the third week, first one and then many of the tiny beaks hammer on prison walls and the downy yellow chicks make their way out of their imprisoning shells. From the incubator


Andalusian


Ancona


Minorca


Leghorn

The hens pictured in the upper row belong to the general-purpose breeds. They are good layers, yet they grow fairly large and bring the poultryman a good price when he sells them for meat. They are favorites with general farmers. The three breeds shown in the center are among the large, heavy meat chickens. The breeds in the lower row include some of the best layers, but they are small chickens and not so profitable to raise for meat.

HATCHING EGGS IN AN ELECTRIC INCUBATOR

Here we see one section of a large hatchery incubator. The eggs are placed in trays high enough so the chicks can stand up after hatching. Heat and humidity are regulated by the instruments on the control board at the right, to match the conditions provided by a setting hen. About 80 per cent of the *fertile* eggs put into an incubator will hatch.

they are put in a warm brooder, where they live the life of pampered little orphans who are not allowed to venture out in the wet grass to hunt their food, but are fed and cared for scientifically.

Hatcheries and the "Battery Method"

In the modern poultry industry, eggs are incubated in large hatcheries, which ship day-old chicks to the farms. The chicks are sometimes tested for *pullorum*, an incurable disease. Their sex may be determined, and the males or cockerels sold to poultrymen who specialize in raising broilers. The females or pullets are sold as future egg-layers and cost three or four times as much as the males.

Many professional poultrymen have eliminated the chicken run, or feeding yard, and raise the poultry entirely indoors. When the "battery method" is employed, the fowls are kept in batteries of wire-bottomed cages several shelves high. Records of growth and egg production indicate that scientifically balanced feeding more than compensates for the lack of outdoor life. The houses may be equipped with ultraviolet lights to replace sunshine. Strict cleanliness reduces disease.

In Europe farmers often drive their poultry flocks out to forage for food. One person is hired to escort all the turkeys in a village, and a goosegirl, or gooseherd tends the geese while they feed. They also drive them along the road to market. In Italy, for example, it is a common sight to see large flocks of geese driven down from the Alps to the nearest market.

Varieties for Meat and for Eggs

There are about 100 standard varieties of domestic chickens, falling into three main classes—Asiatic, Mediterranean, and American. The Asiatic breeds, which originated in China, are large and heavy, being valued as meat producers rather than as layers. The Mediterranean breeds, which come mostly from Italy and Spain, are smaller and noted chiefly for their laying qualities. The American breeds, all of which have been developed in about a century, combine the qualities favorable both to meat and egg production. They are nearly as large as the Asiatic varieties yet include champion laying breeds.

The best-known breeds in the three classes are: (1) Asiatic: Brahmas, Cochins, Langshans; (2) Mediterranean: Leghorns, Minorcas, Spanish, Blue Andalusians, Anconas; (3) American: Plymouth Rocks, Wyandottes, Rhode Island Reds, Dominique, Jersey Black Giant, and Buckeye. England has also produced some distinctive breeds, especially famous for the excellent quality of their meat, including the well-known Orpingtons, the Cornish, the Dorking, and the Sussex. Several muscular, long-necked varieties known as "games," including the Black-breasted Red Game—one of the oldest varieties of domestic

DOWNY, DAY-OLD CHICKS

These tiny chicks have come to life in a hatchery incubator. Now they will be shipped to a poultry farm in a ventilated carton. The trip must be speedy since they can live only three days without food.

fowl known—were developed originally for cockfighting, but they now compare favorably in egg production and are excellent for meat. A wingless breed of bird has been developed with heavy breast meat.

Ornamental varieties are raised chiefly as curiosities, such as the white-crested black Polish fowl, with its white cap of feathers. The bantam breeds are interesting although there is no advantage in their dwarfed size. Delaware is the only state to choose a chicken as its state bird—the blue hen, a game chicken known in Revolutionary War times. (*See also* Duck; Egg; Goose; Turkey.)

POWER. One man can dig a trench in half a day. Another man may be able to dig a similar trench in only two hours. Of the second man we say, quite correctly, that he is more *powerful* than the first. Unfortunately people often use the terms power, force, and energy as if they meant the same thing. Physicists, however, distinguish sharply between these terms, as explained in the article Mechanics.

The power of anything—a man, a horse, a machine, or an electric generator—is its *rate of doing work.* Consider a workman whose job is to shovel earth into a wheelbarrow. At an easy working pace he takes, say, one minute to fill the wheelbarrow. By working faster he can do this in half a minute. In either case he does exactly the same amount of work—the same quantity of earth is moved. By doing the job in half the time, however, the workman is applying twice as much power. The same principle holds true of machines. An engine-driven pump, for example, may deliver 100 gallons of water a minute. To make it deliver 200 gallons a minute, we must apply twice as much power.

SOME COMMON UNITS OF POWER

Power units are based on units of energy, such as the *foot-pound* and the *joule.* Definitions of these terms are given in the article Energy.

1 watt = 1 joule a second
1 kilowatt = 1,000 watts
1 kilowatt = 1.34 horsepower
1 horsepower = 33,000 foot-pounds a minute
1 horsepower = 746 watts

NOTE.—The *kilowatt-hour* is a unit of energy used to measure consumption of electricity. It is the energy supplied by one kilowatt in one hour. Sometimes this unit is wrongly abbreviated to "kilowatt."

Power can be described in many ways. Power units all include an element of time, as can be seen from the table on this page. The term horsepower was first used by James Watt so that the performance of his steam engines could be compared with that of a horse. Actually, only a very strong draft horse can develop one horsepower and then only for a short time. The watt, the most commonly used unit of power in the metric system, was named for this great Scottish inventor.

The Power of Machines

The Age of Power is one of the terms applied to our times. It is a good term. The power of machines to do work makes possible most of the material things we enjoy today. Early men had to depend on the power of their own muscles for everything. Eventually they learned to use the power of animals to carry loads and the power of the wind to drive their ships. Later ancient peoples made some use of water wheels for power. The 18th century brought widespread use of steam for power (*see* Industrial Revolution).

A machine is a device for doing work by changing one form of energy to another. A *prime mover* is a machine which transforms energy from some natural source, such as coal or falling water, into some form suitable for mechanical or electrical use. Examples are steam engines, internal combustion motors, and hydroelectric turbines. Other machines apply the energy so obtained to do work.

The power of a machine can be measured by absorbing a small, constant percentage of the power with a recording device. For example, a *Prony brake* can be clamped to the shaft of an automobile engine while the shaft is turning at high speed. The shaft tends to pull the brake around with it and this pull is recorded by a scale or spring balance. From the number of pounds of pull the engine exerts, its *brake horsepower* can be computed.

The *efficiency* of an engine is the ratio between the energy that goes into an engine and the energy that comes out. Some energy is always lost in friction, and steam and internal combustion engines lose a great deal of unused heat. The general efficiency of a coal- or oil-burning locomotive is rarely as high as 15 per cent. Hydraulic turbines lose little heat and may reach an efficiency of 90 per cent.

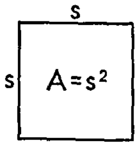
Sources of Energy

The greatest sources of energy in the United States today are the "mineral fuels"—coal, petroleum, and natural gas. Together they supply about 95 per cent of the energy furnished by prime movers for American use. Harnessed water from streams and reservoirs supplies the rest through hydroelectric generating plants. (*See also* United States.)

Engineers and scientists are constantly looking for possible new sources of power. The movements of tides might be used where the rise and fall are great, as in the Bay of Fundy (*see* Tide). Nuclear energy can be released by atomic fission in atomic reactors, or furnaces. Tremendous heat from the reaction can be used to produce steam or vaporized metal for running turbines. The uranium or other material used, however, is scarce and expensive (*see* Atoms).

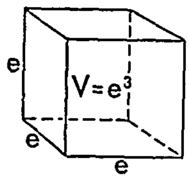
The most promising future sources of power are the sun and the earth themselves. Every day tremendous quantities of radiant energy from the sun pour down upon the earth and help support life in plants and animals. Great quantities of heat energy are also locked up in the interior of the earth. Scientists and engineers, however, have not yet discovered practical, large-scale devices for drawing energy directly from these sources for mechanical and other uses. Small beginnings have been made with mirrors for focusing *solar heat* to make steam, with window arrangements for solar heating of houses, and with the *heat pump* (*see* Heating and Ventilating).

POWERS AND ROOTS. The subject of *powers* is closely related to multiplication. The subject of *roots* is closely related to division.



Powers. The algebraic formula for the area of a square is $A=s^2$ (*see* Measurement). A represents *area* and s represents one *side* of the square. We read s^2 as "s (side) squared"; it means $s\times s$. In like manner, $3^2=3\times3=9$, and $10^2=10\times10=100$. To square a number, we simply multiply it by itself. The square of a number is called the *second power* of the number.

The formula for the volume of a cube is $V=e^3$ (*see* Measurement). In this formula, e represents the length of one edge of the cube. We read e^3 as "e cubed"; it means $e\times e\times e$. In like manner $2^3=2\times2\times2=8$, and $5^3=5\times5\times5=125$. The cube of a number is the *third power* of the number.



In the same way we can find the *fourth power*, the *fifth power*, or any other power of a number. For example, 3^4 (3 to the fourth power) $=3\times3\times3\times3=81$; 10^5 (10 to the fifth power) $=10\times10\times10\times10\times10=100{,}000$. It will be seen that, except for very small numbers, the higher powers of a number are very large.

The *first power* of a number is simply the number itself. For example, $7^1=7$. We do not ordinarily talk about the first power of a number.

The power of a number is indicated by a small figure written a little above and to the right. This small figure is called the *exponent.* In 8^3, for example, the exponent is 3; it tells us that 8 is to be raised to the third power. The exponent 1 is seldom written; if no exponent appears on a number, it is understood that the exponent is 1.

In algebra it is shown that any number with an exponent of 0 is equal to 1. Thus, $3^0=1$; $10^0=1$. It is also shown in algebra that exponents can be negative numbers. Any number with a negative exponent is equal to 1 divided by that number with a positive exponent. For example, $7^{-2}=\frac{1}{7^2}=\frac{1}{49}$.

Roots. The sign $\sqrt{\ }$ means "square root of." We know that $6^2=36$; then the square root of 36 is 6, or $\sqrt{36}=6$. The square of 12 is 144; then the square root of 144 is 12, or $\sqrt{144}=12$.

The sign $\sqrt[3]{\ }$ means "cube root of." Similarly there are 4th roots, 5th roots, 10th roots, and so on. The cube of 4 is 64; that is, $4^3=64$. Then, the cube root of 64 is 4; that is $\sqrt[3]{64}=4$.

How to Use the Table of Squares and Square Roots

Cubes and cube roots have much less practical use than have squares and square roots. Those who do have occasion to find cube roots of numbers usually use logarithms (*see* Logarithms).

To find the square or the square root of a number it is convenient to use a table. Such a table appears on this page. This table shows the squares and the square roots of numbers from 1 to 150. Square roots are shown to two decimal

TABLE OF SQUARES AND SQUARE ROOTS

N	N²	√N	N	N²	√N	N	N²	√N
1	1	1.00	51	2,601	7.14	101	10,201	10.05
2	4	1.41	52	2,704	7.21	102	10,404	10.10
3	9	1.73	53	2,809	7.28	103	10,609	10.15
4	16	2.00	54	2,916	7.35	104	10,816	10.20
5	25	2.24	55	3,025	7.42	105	11,025	10.25
6	36	2.45	56	3,136	7.48	106	11,236	10.30
7	49	2.65	57	3,249	7.55	107	11,449	10.34
8	64	2.83	58	3,364	7.62	108	11,664	10.39
9	81	3.00	59	3,481	7.68	109	11,881	10.44
10	100	3.16	60	3,600	7.75	110	12,100	10.49
11	121	3.32	61	3,721	7.81	111	12,321	10.54
12	144	3.46	62	3,844	7.87	112	12,544	10.58
13	169	3.61	63	3,969	7.94	113	12,769	10.63
14	196	3.74	64	4,096	8.00	114	12,996	10.68
15	225	3.87	65	4,225	8.06	115	13,225	10.72
16	256	4.00	66	4,356	8.12	116	13,456	10.77
17	289	4.12	67	4,489	8.19	117	13,689	10.82
18	324	4.24	68	4,624	8.25	118	13,924	10.86
19	361	4.36	69	4,761	8.31	119	14,161	10.91
20	400	4.47	70	4,900	8.37	120	14,400	10.95
21	441	4.58	71	5,041	8.43	121	14,641	11.00
22	484	4.69	72	5,184	8.49	122	14,884	11.05
23	529	4.80	73	5,329	8.54	123	15,129	11.09
24	576	4.90	74	5,476	8.60	124	15,376	11.14
25	625	5.00	75	5,625	8.66	125	15,625	11.18
26	676	5.10	76	5,776	8.72	126	15,876	11.22
27	729	5.20	77	5,929	8.77	127	16,129	11.27
28	784	5.29	78	6,084	8.83	128	16,384	11.31
29	841	5.39	79	6,241	8.89	129	16,641	11.36
30	900	5.48	80	6,400	8.94	130	16,900	11.40
31	961	5.57	81	6,561	9.00	131	17,161	11.45
32	1,024	5.66	82	6,724	9.06	132	17,424	11.49
33	1,089	5.74	83	6,889	9.11	133	17,689	11.53
34	1,156	5.83	84	7,056	9.17	134	17,956	11.58
35	1,225	5.92	85	7,225	9.22	135	18,225	11.62
36	1,296	6.00	86	7,396	9.27	136	18,496	11.66
37	1,369	6.08	87	7,569	9.33	137	18,769	11.70
38	1,444	6.16	88	7,744	9.38	138	19,044	11.75
39	1,521	6.24	89	7,921	9.43	139	19,321	11.79
40	1,600	6.32	90	8,100	9.49	140	19,600	11.83
41	1,681	6.40	91	8,281	9.54	141	19,881	11.87
42	1,764	6.48	92	8,464	9.59	142	20,164	11.92
43	1,849	6.56	93	8,649	9.64	143	20,449	11.96
44	1,936	6.63	94	8,836	9.70	144	20,736	12.00
45	2,025	6.71	95	9,025	9.75	145	21,025	12.04
46	2,116	6.78	96	9,216	9.80	146	21,316	12.08
47	2,209	6.86	97	9,409	9.85	147	21,609	12.12
48	2,304	6.93	98	9,604	9.90	148	21,904	12.17
49	2,401	7.00	99	9,801	9.95	149	22,201	12.21
50	2,500	7.07	100	10,000	10.00	150	22,500	12.25

places. The table shows, for example, that the square of 37 is 1,369 and that the square root of 37 is 6.08, to the nearest hundredth.

We can use this table to estimate the square roots of many numbers larger than 150. For example, what is the square root of 800? Looking in the N^2 column of the table, we see that 784 is the square of 28 and 841 is the square of 29. In other words, the square root of 784 is 28 and the square root of 841 is 29. The square root of 800 must therefore be between 28 and 29 Since 800 is closer to 784 than to 841, the square root of 800 must be closer to 28 than to 29. We might guess the square root of 800 to be 28.4. Squaring 28.4, we get 806.56, which is more than 800. Next, we try 28.3. Squaring 28.3, we get 800.89, which is very little more than 800. The square of 28.2 is 795.24. Apparently then, the square root of 800 is 28.3, correct to the nearest tenth.

How to Find the Square Root of a Number

The square root of any number can be found by a method which resembles division and which can be proved by algebra. Suppose we want to find the square root of 181,476. First we separate the number into *periods* of two figures each, beginning at the right. The following steps are taken in working the example:

```
      18'14'76 |426
      16
   82 | 214
      | 164
  846 | 5076
      | 5076
```

1. The square root of the first period (18) is 4+. Write 4 as the first figure of the answer.
2. Square the 4, write 16 under 18, draw a line and subtract. The remainder is 2. Bring down the next period (14).
3. Double the 4 in the answer, writing 8 to the left of 214. Get the second figure of the answer by dividing 21 by 8. Write 2 as the second figure of the answer and also to the right of the 8.
4. Multiply 82 by 2, writing 164 under 214. Draw a line and subtract. The remainder is 50. Bring down the next period (76).
5. Double the 42, writing 84 to the left of 5076. Get the third figure of the answer by dividing 50 by 8 Write 6 as the third figure of the answer and to the right of 84.
6 Multiply 846 by 6, writing 5076 under 5076. There is no remainder. The square root of 181,476 is 426.

To check the answer, multiply 426 by 426. The product is 181,476.

In the case of a decimal mixed number, begin with the decimal point and separate the number into periods to the left and to the right. In the example shown, we annex two zeros to 538.71 because we want two decimal places in our answer. The work may be carried through additional places if desired.

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       5'38.71'00 |23.21
       4
   43 | 138
      | 129
  462 | 971
      | 924
 4641 | 4700
      | 4641
           59
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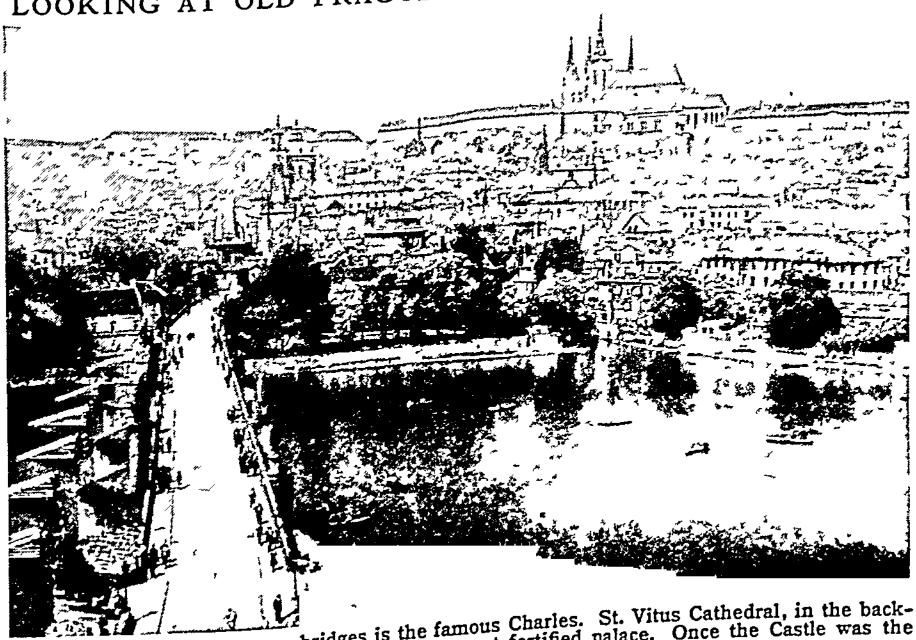
PRAGUE (*prăg* or *prāg*); Czech, **PRAHA** (*prä'hä*), CZECHOSLOVAKIA. The beautiful city of Prague is the capital and largest city of Czechoslovakia. It is situated in the western end of the long narrow country, near the center of the Bohemian plateau. Hills surround the city, and the northward flowing Vltava, a tributary of the Elbe River, flows through it. Many bridges cross the river. The greater part of the city lies on the east, or right, bank.

On the west bank the famous Castle of Prague, a medieval walled city, crowns a steep hill. At the foot of the hill lies the Small Town, which contains many old churches and other medieval buildings.

Oldest and most picturesque of the bridges is Charles Bridge, with its two towers and statues of saints. From the eastern end of Charles Bridge twist narrow lanes of the Old Town, which centers around Old Town Square. Both the Old Town and the New Town, which adjoins it, retain much of their ancient appearance. Residential districts, interspersed with parks, spread over terraced slopes and valleys.

In the Castle area stands the Gothic Cathedral of St. Vitus, which has been restored twice since the prince-saint Wenceslas founded it in 930. From the

LOOKING AT OLD PRAGUE OVER THE CHARLES BRIDGE



The oldest of Prague's many bridges is the famous Charles. St. Vitus Cathedral, in the background, stands in the center of the Castle, a vast fortified palace. Once the Castle was the home of the kings of Bohemia. Now it is the seat of the Czechoslovak government.

Old Town Square on the east bank rises the Týn Church, more than 500 years old. The main business district hugs the Old Town Square. Scattered through the city are the many buildings of the University of Prague, founded in 1348. The Bohemian national hero and martyr, John Huss, was one of its most famous lecturers (*see* Huss).

Streetcar and bus lines lead east and west from the "Old Town" to modern Prague, a district of apartment houses and wide, regular streets. Here also are extensive parks with natural terraces.

The beginnings of Prague are unknown, but by the latter part of the 10th century it was an important city. In the 14th century it was one of Europe's greatest centers of culture, political power, and trade. The countryside supplied barley, hops, and livestock. From the mountains came timber, coal, and iron.

After the first World War, Prague's industries expanded enormously. They included sugar refineries, chemical plants, breweries, and railroad shops. The city's trade and industry declined when Czechoslovakia fell under Communist control in 1948. Population (1945 census), 934,933.

PRAIRIE DOG. A visitor's first view of a prairie dog "town" shows little hillocks, with small animals sitting on each one. As the visitor approaches, the animals start barking, and then dive into the hillocks.

These little creatures are not dogs. They are gnawing animals (rodents) of the squirrel family. They live in burrows, and the dirt they dig out makes the hillocks. The burrows go sharply down, sometimes a dozen feet or more. A small side chamber part way down is used apparently as a place to listen. There the prairie dog decides whether to venture out or to plunge deeper into its burrow.

PRAIRIE DOG

This cheerful-looking little animal is watching while he eats. At the first hint of an enemy, he will whisk into his burrow near by, and plunge deep underground.

From the bottom of the steep main shaft, a horizontal tunnel turns off sharply. It branches into one or more short, sloped-up passages leading into sleeping and nursery chambers filled with grass. The hillock at the mouth of the burrow serves to keep out water when a sudden rain floods the surrounding ground. To build these mounds, the "dogs" gather earth with their front paws and hammer it firmly into place with their blunt, hard noses.

In the summer the prairie dogs eat grass, alfalfa, and other low-growing plants. By autumn they have grown very fat. In the colder parts of their range they hibernate for a short period.

Prairie dog colonies are very common on the plains of Montana, Wyoming, western Kansas, Texas, New Mexico, and Arizona, and on the slopes of the Rockies in Utah and Colorado. Weasels, badgers, and snakes prey on the prairie dogs and keep down their numbers. Burrowing owls often live in deserted holes. When settlement of the country cut down the natural enemies, prairie dogs increased until they became a nuisance. One colony in Texas was about 250 miles long and 100 miles wide. One square mile in eastern Arizona contained 7,200 burrows by actual count.

There are several varieties of prairie dogs in North America, including the black-tailed, white-tailed, Gunnison, and Utah types. All have thick, fat bodies, about 14 inches long (including the short tails), and weighing 2 to 3 pounds. They have low, rounded ears, short legs, and cheek pouches. The upper parts are reddish or buff, streaked with black; the under parts are white or buff. Males and females look alike. The animals shed their coats twice a year. Four to eight young are born in May or June and they grow rapidly. Scientific name, *Cynomys ludovicianus.*

The AGELONG STORY *of* PREHISTORIC *Life*

PREHISTORIC LIFE. Before white men came to North America, Indians lived on most parts of the continent. They left many relics where they camped, and ruins tell where some tribes built towns in valleys and on mountainsides. But these Indians left no written records of themselves, and so we say that they were *prehistoric* ("before history").

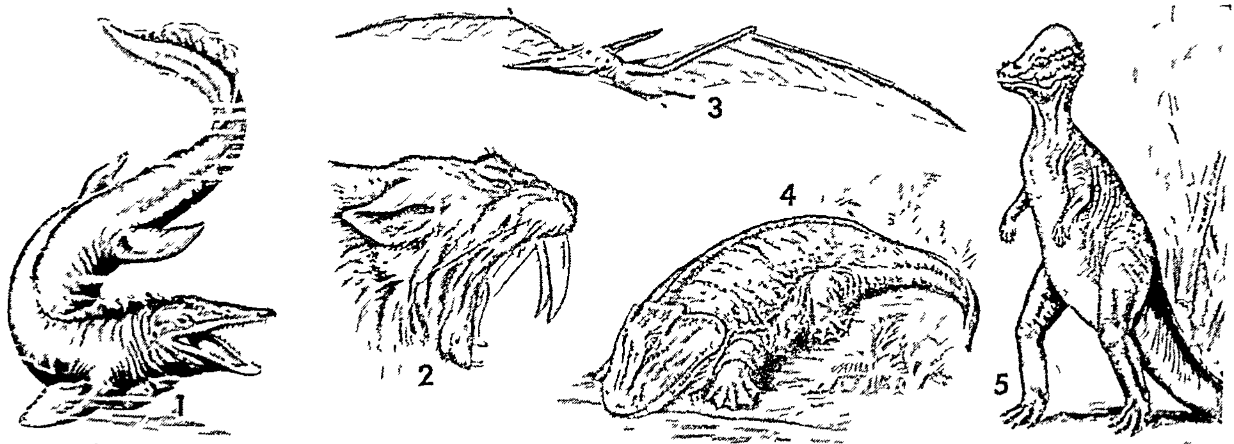
Prehistoric life and times did not begin with the Indians. Scientists tell of an earlier period, the Ice Age, when climates grew cold and animals such as elephants and rhinoceroses had coats of woolly hair. According to some estimates, the Ice Age lasted about a million years; but prehistoric life had passed through many stages before the Ice Age began.

Some of the most fearsome creatures ever known lived in the Era of Reptiles. Those were the days of dinosaurs, flying "lizards," and swimming reptiles that looked like sharks or huge eels. A still earlier time was the Coal Age. Vast swampy forests then covered much of the land, and dragon flies with wings two and a half feet wide hunted smaller insects in the thick, green woods.

During still earlier times, there was little or no life on land. Animals and most plants lived in shallow seas. There some creatures covered themselves with armor; others built cone-shaped shells as much as twelve feet long.

Thus the story of prehistoric life has run through many ages and stages. In all these scientists trace two kinds of progress. One kind turned early plants and animals, which were very simple, into new and more complex kinds. The other kind of progress has enabled plants and animals to adapt themselves to new ways of living so they could survive in all possible parts of the earth. Today there are forms adapted to life in hot tropical forests, in deserts, on high moun-

THESE STRANGE CREATURES LIVED IN BYGONE AGES



Many strange beasts have lived during the long ages of earth history. The mosasaur (1) was a huge seagoing reptile of the Chalk Age. Animals and early man feared the saber-toothed tiger (2). The pterosaur (3) was a Chalk Age flying reptile. The huge amphibian (4) lumbered about much earlier. A curious Chalk Age dinosaur was the "bonehead" (5), so-called from the heavy bones of his skull. Later pictures show other animals of bygone ages, beginning with the earliest creatures which left a clear fossil record.

tains, in deep seas, in fresh-water lakes and rivers, and even at the edges of polar ice fields.

Early Life in the Sea

Scientists cannot give any definite, detailed explanation of how or when life appeared on the earth. But they do offer a clear account of the development achieved about a half billion years ago. At this time, shallow seas covered many places that have now become land. Jellyfish drifted about in the water; vase-shaped sponges grew on the bottom; small shellfish and jointed worms crawled about under green and brown seaweeds.

On the sea bottom also lived the earliest trilobites. They were jointed creatures related to the modern horseshoe crab. Some trilobites were oval and smooth, but others had goggle eyes and spiny shells made up of several sections. These creatures crawled and swam with feathery legs and used jointed "feelers" to find food. Trilobites six to seven inches long were the largest animals in those early seas. (For other pictures, *see* Fossils; Trilobite.) Sharks, true fishes, and such warm-blooded animals as whales were absent. No creatures like these would appear on the earth until much later times.

When Life Took to the Land

Scientists feel sure that life began in water. As the ages passed, however, plants began to live on the land. Early forms were algae, lichens, and probably mosses. But in time, forests of trees began to grow on low, swampy land. Some of the trees had thick trunks and big, fernlike leaves, but other trees were slender. There were thickets of jointed rushes beside forest pools.

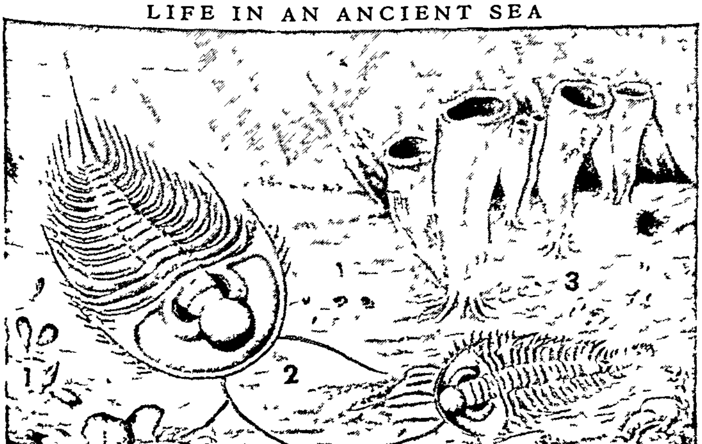
By that time fishes had developed and were flourishing in the seas. Some forms, two to three feet long, also lived in pools on land. They had bony heads, sharp teeth, and simple lungs as well as gills. If the pools were made foul by decaying plants, these fishes raised their heads out of the water and breathed air. Often the pools dried up. Then the fishes used their thick, short fins to crawl over narrow strips of land to ponds that still contained water.

Descendants of certain crawling fishes developed legs from fins and could crawl more easily. They became amphibians, a group of animals that has produced modern salamanders, frogs, and toads. The first amphibians must have looked like salamanders three to four feet long, with sharp teeth and wide heads. They could crawl and breathe on land but still spent most of their lives in shady forest pools.

Forests and Animals of the Coal Age

During the next 50 million years plants and animals changed greatly. In the latter part of the Coal Age trees as much as a hundred feet high grew in swampy forests. (For a picture in color, *see* Coal.) Spiders and scorpions were common. Cockroaches grew four inches long, and giant dragon flies were larger than many of our modern birds. Amphibians had become large too. Some were as big as most alligators; others were broad-bodied creatures that weighed 500 to 600 pounds. Reptiles had appeared by this time,

LIFE IN AN ANCIENT SEA



The oldest clear record of life comes from early Cambrian times. There is no evidence of life on land in this period; as far as anyone knows, everything lived in water. Among the animals of that early day were: (1) lamp shells (brachiopods), (2) trilobites, and (3) limy sponges. Geologists think these animals lived about 500 million years ago.

but they were smaller than the huge amphibians. They ranged in size from a few inches to three or four feet in length. Some of them were built so much like amphibians that scientists can hardly tell to which group they belonged.

Life in the Era of Reptiles

When prehistoric reptiles are mentioned, many people think of huge dinosaurs. The first dinosaurs, however, were slender creatures no larger than a turkey. They lived long after the Coal Age, walked or ran upon their hind legs, and used their long tails to balance their bodies.

As millions of years went by, the descendants of these first dinosaurs grew larger and larger. The dinosaurs that began to walk on four legs became the biggest animals that ever lived on land.

Those giants lived during the second age in the Era of Reptiles, about 150 million years ago. Their homes were deep swamps surrounded by forests. Through the swamps waded plant-eating dinosaurs, from 18 to 90 feet long. They had thick bodies and legs, long necks, and still longer tails. When they were hungry they pulled up water plants and swallowed them without chewing. When danger threatened, they waded into deep water. They could stand on the bottom of a swamp for hours, with only their nostrils above the surface, to take breaths of air.

Danger almost always came from forests, where many other dinosaurs lived. Some were reptiles five to eight feet long, which still walked on their hind legs, ate plants, and could run rapidly. Another plant-eater was 20 feet in length and 10 feet high. This creature had two rows of bony plates on its back and long, bony spikes on its tail. Instead of running away from danger, this dinosaur swung its tail to and fro. The spikes delivered terrible blows against anything that came near them.

The only animals that could harm these giants were other dinosaurs. They were savage creatures 30 to 35 feet long, with big heads and wide mouths set with daggerlike teeth. They stood on long, powerful hind legs, and their toes were armed with sharp, curved claws. Though they could not run very far, they often dashed out of the woods and pounced upon swamp-dwelling dinosaurs that came too near the shore.

During the many millions of years that followed, new kinds of reptiles developed and then became extinct, or died out. Among them were flying reptiles; others lived in water and looked like eels and sharks. (For pictures, *see* Reptiles.)

The Rise of Birds and Mammals

Both the amphibians and the reptiles had made important advances in adapting themselves for life on land. Now improvements were appearing in other types of creatures, the birds and the mammals.

Today birds seem distinctive because they can fly But some of the earlier reptiles could fly. The great improvement made by birds was *warm blood.* The reptiles were cold-blooded and became sluggish or torpid when the weather grew cool. The warm-blooded birds could live under conditions and in regions which would have been impossible for the older creatures. And they could conserve heat in the body and blood because they had a distinctive covering of *feathers.* (*See also* Birds.)

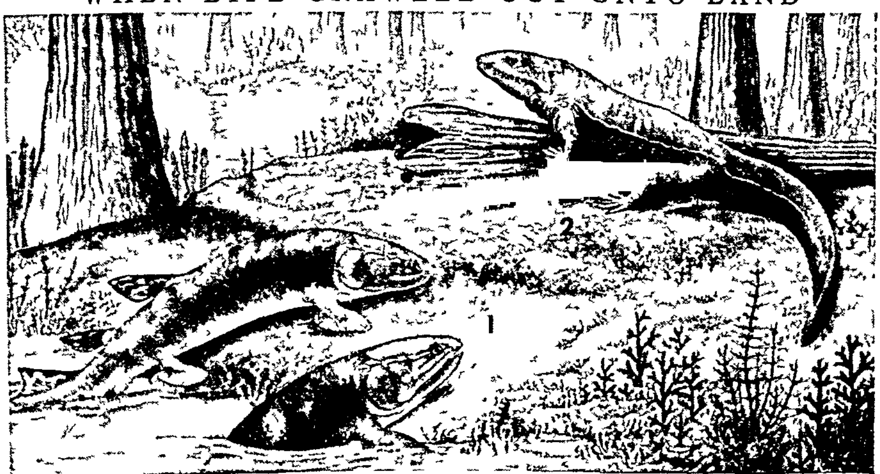
Mammals also had warm blood and a coat of hair that conserved body heat. Their great advance beyond the birds lay in their method of reproduction. Birds, like the reptiles, reproduced by laying eggs. The eggs had to be hatched, and they were exposed to destruction during the incubation period. Mammals developed their young within the mother's body, and the young were born alive. Thereafter for a time the mother fed them with milk produced in her body, just as cows, dogs, and cats do today.

The Host of Early Mammals

About 30 million years ago, great numbers of mammals lived in the western part of North America. Their home was a level, grassy land dotted with groves of oaks, maples, and other familiar trees Rats, mice, and squirrels lived in the groves, and herds of beasts called *titanotheres* came there to rest in the shade. The largest titanothere looked like a rhinoceros eight feet high and as heavy as an elephant. On its nose were two long, blunt horns of bone covered with hard skin.

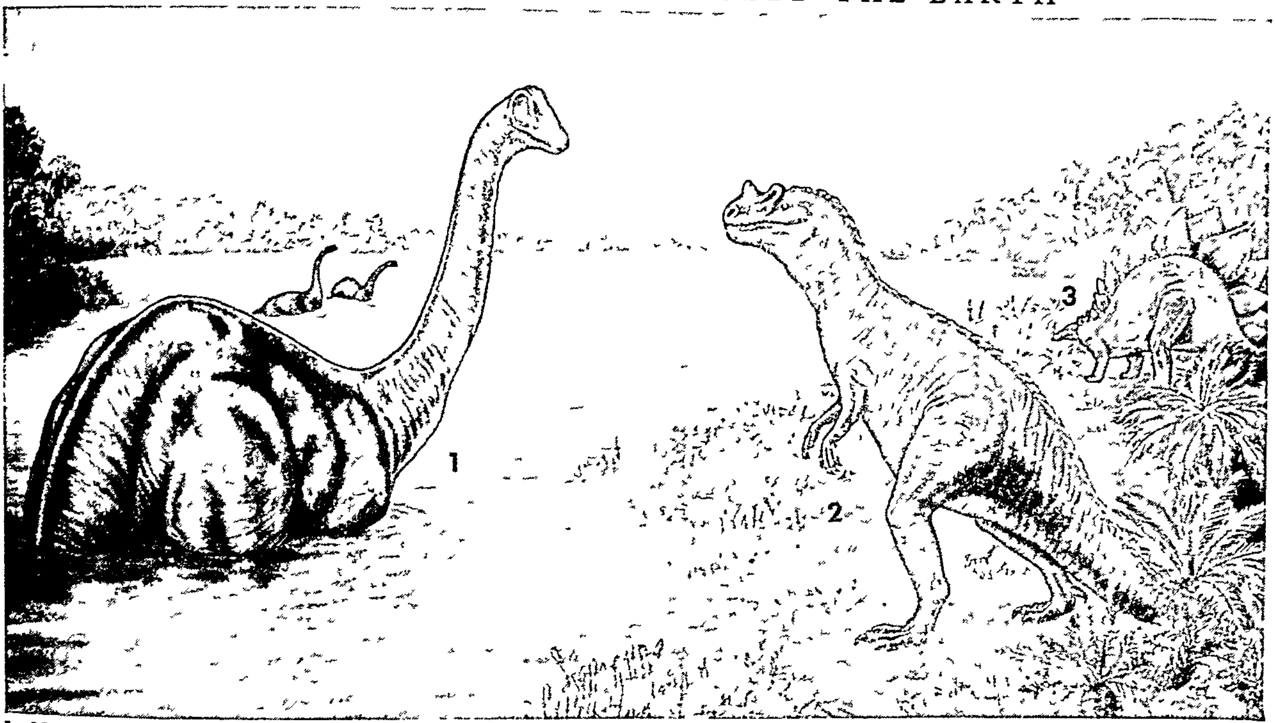
Three-toed horses no larger than sheep roamed the grassy plains. There also were little camels that had no humps, small rhinoceroses without horns, and several plant-eating

WHEN LIFE CRAWLED OUT ONTO LAND



In Devonian times, about 300 million years ago, both plants and animals such as insects and spiders were plentiful on land. In shallow ponds lived bony fish with sharp teeth (1). They had stubby fins which they could use as legs, and lungs as well as gills. If the pool where they lived dried up, they crawled across land to another. A more advanced creature was the amphibian (2). Like modern salamanders and frogs, it lived in water when it was young, but spent its adult life on land.

WHEN GIANT REPTILES RULED THE EARTH



In Mesozoic times, some of the reptiles called dinosaurs became the largest creatures ever seen on land. Huge, clumsy plant-eaters waded in swamps. Meat-eaters, which were not so large, lurked on land, waiting their chance to pounce upon a meal. Here a plant-eater (1) called Diplodocus is just beyond reach of the horned hunter (2) called Ceratosaurus. Diplodocus was about 87 feet long; 48 feet show above water. In the background is an armored dinosaur, Stegosaurus (3). It is ready to fight if the baffled hunter turns upon it. This scene is from life in Wyoming, at a time estimated as 150 million years ago.

beasts that have no living relatives. Among these were the so-called giant pigs, five to six feet in height. They had bony lumps on the sides of their heads and strong tusks which they used in digging roots and in fighting with each other.

Meat-eating, or carnivorous, beasts were common, but they were not very large. The most agile were saber-toothed "cats" that looked rather like small leopards. Larger beasts that resembled hyenas probably fed on dead bodies of other animals. They were much too slow to catch living horses and camels, and they could not break the shells of tortoises that wandered over the plains.

Animals of the Ice Age

During the latter part of the Ice Age, about 150,000 years ago, there was a time when glaciers melted and climates became moderate. Pines, firs, oaks, poplars, and other modern trees grew in thick forests. The titanotheres and their neighbors had died out, but hairy elephants with long, curved tusks roamed on high, dry land. Mastodons, which were smaller and had very different teeth, fed in valleys and bogs. They sometimes sank into the mud so deeply that they could not get out.

Herds of musk-oxen, wild horses, and bison roamed grassy lands between the forests. The bison were huge animals with horns six feet wide. Some of the wild horses were small, but others were large. All had a single hoof on each foot, like the horses that are living today. (For pictures, *see* Horse.)

Perhaps the strangest of these Ice Age beasts were the ground sloths. They were awkward creatures as big as an ox or larger, with shaggy hair and skin that contained pieces of bony armor. Although they had powerful claws, the ground sloths were peaceful creatures that ate leaves and roots. Perhaps they also used their claws to defend themselves when they were attacked by saber-toothed "cats." These beasts had become as large as present-day lions, though they had thicker legs and shoulders and could not run very fast. Unlike both lions and tigers, these big saber-tooths had stubby tails.

Glimpses of Prehistoric Men

Comic strips often show prehistoric men with dinosaurs, flying reptiles, and huge amphibians of the Coal Age. Actually, human beings did not appear until the Era of Reptiles had gone and most of the Age of Mammals had passed. The oldest people whose remains have been discovered lived during the early part of the Ice Age.

Ice Age people were of many kinds and races. Some had low foreheads and thick ridges of bone above their eyes. A few had small heads and brains, but others had very big heads. One short, big-headed group, the Neanderthalers, lived in Europe during one of the coldest parts of the Ice Age. Another group of ancient men, the Cro-Magnons, were tall and had broad faces. Both groups made tools and weapons of stone and generally lived in caves. (*See also* Man.)

Before the Ice Age ended, human beings made their way from Asia to North America. Their stone weapons have been found with bones of mammoths, small horses, and ancient bison. This proves that ancient Americans hunted Ice Age beasts, but it does not tell what

the hunters were like or when they came from Asia. Estimates range from 15,000 to 25,000 years ago.

Records of Prehistoric Life

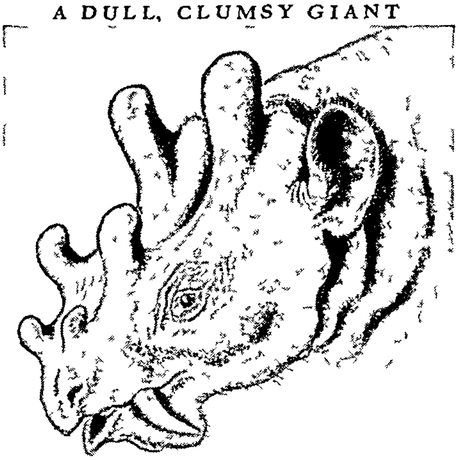
The story of prehistoric men is told by their homes, their weapons, and other things they made, as well as by their bones. The story of other animals and of plants is recorded only by fossils, which are the remains or traces left by things that lived during very ancient times.

Some fossils of the Ice Age are found in swamps, frozen ground, or ice. But most fossils are preserved in beds of rock such as clay, sandstone, or limestone. Geologists can usually tell about when each fossil-bearing deposit was formed. When the fossils of various deposits are arranged in order, they tell scientists the story of prehistoric life from very ancient to recent times. (*See* Fossils; Geology.)

Great Changes Have Divided Earth History

There have been made divisions, or ages, in the story of prehistoric life because the earth itself has changed over and over again. At certain times regions now land have been covered by seas as parts of continents sank under salt water. At other times the lands were low, with swamps and moist climates. At still other times, sea bottoms were pushed up into land; lowlands became hills that slowly turned into mountains. When one of these changes affected most of the world it brought one age (or period) to an end and began a new one. At least 15 of these world-wide changes are known; still others may be discovered as the records of earth's most ancient times are studied more carefully by geologists and other scientists.

A DULL, CLUMSY GIANT



This strange beast appeared in the West a few million years after the Age of Mammals began. Called Uintatherium, it was as big as an elephant but much more stupid, and its blunt horns were of little value as defense. Such an animal could not have developed during the days when meat-eating dinosaurs ruled the land.

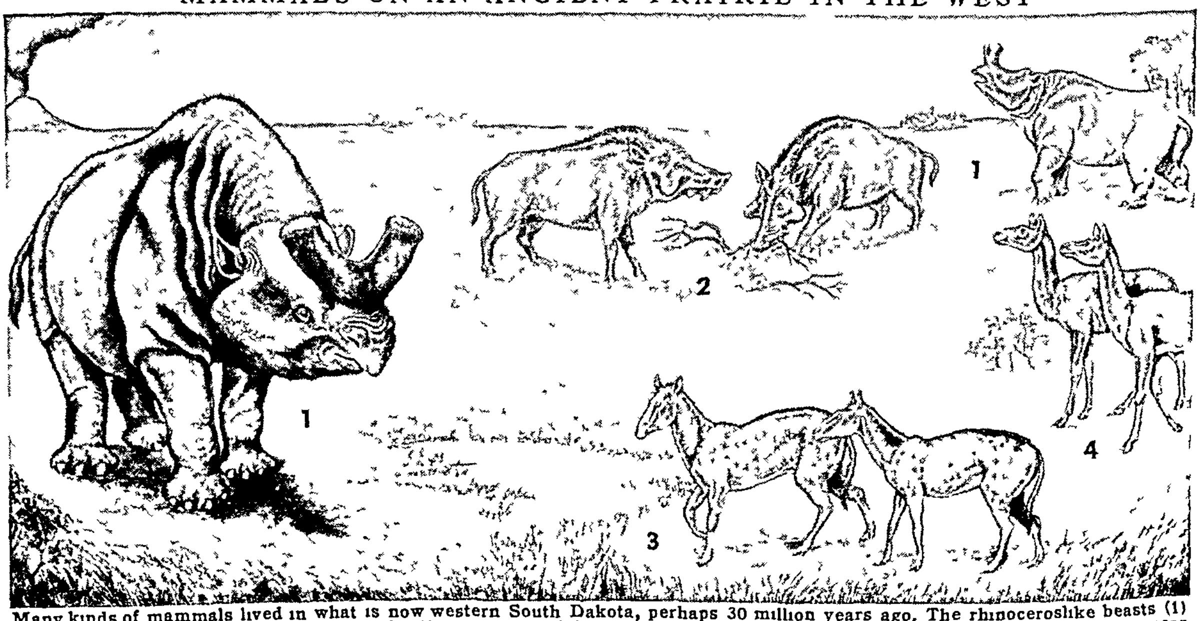
Now and then an earth-change was so great that geologists call it a revolution. There was a revolution several million years before trilobites first became common. At least four other revolutions were as great as this one. They divided earth's history into parts called eras, and each era had several ages. The era during which trilobites lived contained six or seven ages, and the Era of Reptiles had three.

Living Things Also Changed

As the earth was changing, living things were "growing up." Both plants and animals started out as one-celled living things. Gradually new forms appeared, as many cells gathered together and began to perform different functions (*see* Life). These new forms survived or perished, according to how well they were able to win a living from their surroundings.

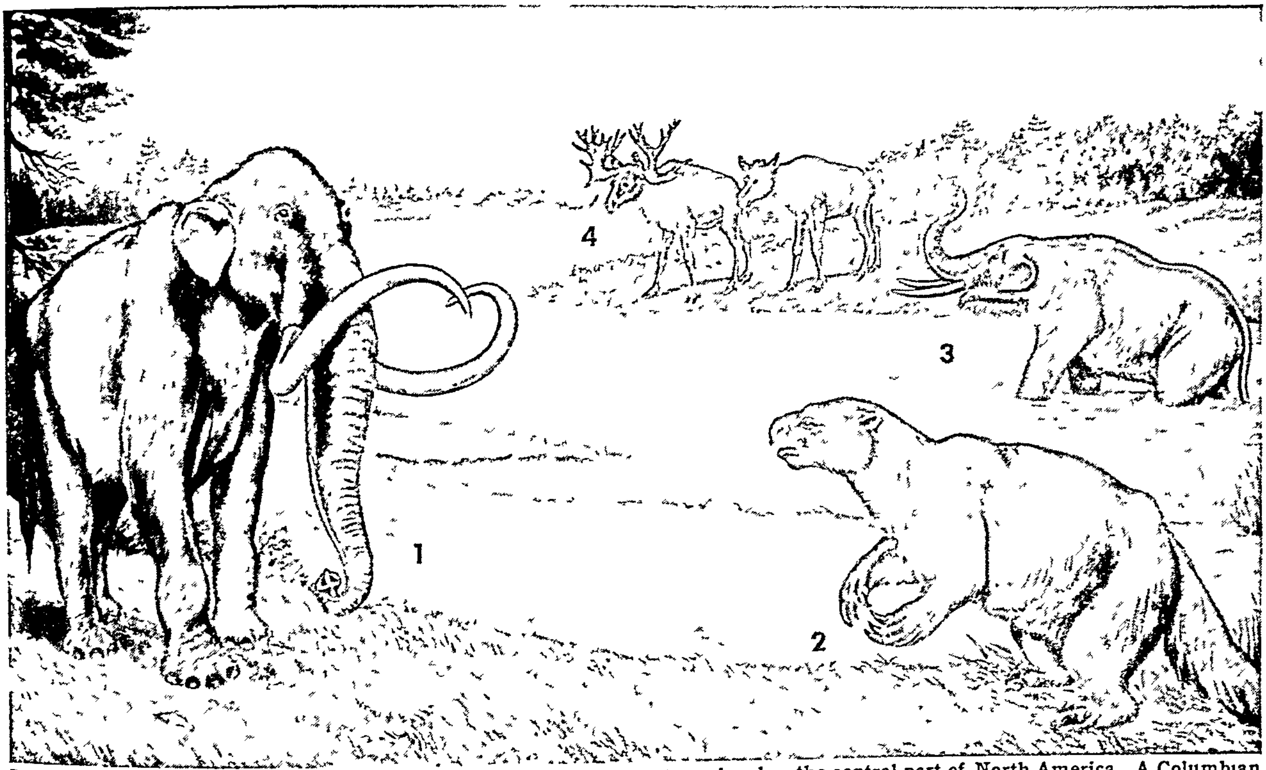
There were many times during the past when living conditions were easy. During these times, new forms of plant and animal life appeared; but older, estab-

MAMMALS ON AN ANCIENT PRAIRIE IN THE WEST



Many kinds of mammals lived in what is now western South Dakota, perhaps 30 million years ago. The rhinoceroslike beasts (1) were titanotheres. They soon died out. Another unsuccessful type was the so-called giant pig (2). Better adapted types appear at the lower right. The three-toed horse (3) was an ancestor of the modern one-toed animal. The early camels (4) had no humps, but they were the ancestors of the llamas, guanacos, and humped camels that now live in South America, Africa, and Asia.

ICE-AGE FORERUNNERS OF PRESENT-DAY MAMMALS



During one of the warm intervals which broke the Ice Age, these creatures lived in the central part of North America. A Columbian mammoth (1) is marked by its long, curved tusks. Facing him is a ground sloth (2), much larger than the tree sloths that now live in tropical forests. A mastodon (3) is wading in the swampy river, and in the distance two moose deer (4) are coming to drink.

lished forms continued to flourish. After each period of easy living, however, came an earth-change or a revolution. It destroyed old conditions of life and produced a new and very different set of conditions. Many old plants and animals could not live in their new surroundings and thus died out. So did some of the newly developed forms, but others got along very well. They therefore remained alive, and in time their descendants covered the earth with new plants and animals.

Reptiles and a Revolution

The connection between earth-changes and new kinds of plants and animals is shown by the Era of Reptiles. Throughout most of the world it was a time of low, moist lands, broad seas, and mild climates. These easy conditions for life allowed a great variety of reptiles to develop on land, in fresh water, and in the sea. At the same time, warm-blooded mammals that resembled opossums also appeared. Most of them remained small, for only small animals could escape the hordes of hungry reptiles.

Then came an earth revolution that turned sea bottoms into land, pushed swamps upward into hills, and made hills and plateaus into mountain ranges. It brought drier, more changeable climates, with hot summers and chilly winters. Life became harder and harder for the reptiles, which died off one after another. The new conditions, however, were good for the mammals. Even before the revolution ended they were almost as plentiful as reptiles had been in earlier eras, and today they dominate the entire earth. (*See also* Reptiles.)

PREPOSITION. When we say "a girl with yellow hair," the group of words "with yellow hair" means the same as the adjective "yellow-haired." In the sentence "The people gathered in haste," the words "in haste" are equivalent to the adverb "hastily." Such groups of words are called *prepositional phrases*. They are called *adjective* or *adverbial* phrases, according to whether they modify nouns or verbs.

All such phrases have an introductory word, usually a short one, like *in*, *for*, *by*, *with*, *against*, and so on. This introductory word is called a *preposition*, from the Latin *praepositum* meaning "placed before." It is placed before the substantive it introduces (governs). The preposition shows that the word it governs applies to the word which the phrase modifies. In the sentence "It will rain before tomorrow," the preposition *before* shows a time relation between the verb *will rain* and the noun *tomorrow*.

Though there are comparatively few prepositions, they express a great variety of relationships, such as time, place, manner, means, agency, cause, accompaniment, opposition, source, destination, and so on. The same preposition may express several of these relations in different uses: as *with* a hammer (*means*), *with* speed (*manner*), *with* me (*accompaniment*), to fight *with* someone (*opposition*).

Misuse of these important little words is a common error in speaking and writing. You will often hear careless speakers say, "I went *in* the house," for "*into* the house"; "I got the book *off of* him," for "*from* him"; "He is staying *over to* my house," for "*at* my house"; "She wasn't *to* home," for "*at* home."

The PRESIDENT—*First Citizen of the* UNITED STATES

PRESIDENT OF THE UNITED STATES. It has often been said that the president of the United States exercises more power than any other elected ruler of modern times. It is indeed true that few republics have given their chief executive a power comparable to that of the United States president.

This power had its beginnings when the Constitution of the United States took effect in 1789. Before this time the 13 original states had suffered from the weak central government provided by the Articles of Confederation (*see* Articles of Confederation). The men who planned the new government wanted a strong central governing authority. They chose a single executive, the president, and gave him firm powers. But they checked and balanced the powers of the president by the powers they gave to the legislative and judicial branches (*see* United States Government). Thus they hoped to ensure a strong president, yet one who could not become powerful enough to be a dictator or a despot.

Both the nation and the powers of the president have grown tremendously since that time. Today the president is the focus of all federal authority and a respected leader in world affairs. Yet the original principles of firm powers, controlled by checks and balances, have been preserved.

How the Office of President Is Protected

The president is assured stability in office by election for a term of four years. He cannot be removed from office before his term expires except by conviction on impeachment (*see* Impeachment). Only one president has been impeached, and he was not convicted (*see* Johnson, Andrew).

Originally the Constitution placed no limit on the number of terms a president could serve. In 1947 Congress passed and sent to the states a proposed 22d amendment. It limited a president to two full terms or to ten years if he served a part of another's term. It excepted the president in office at that time (Harry S. Truman). The amendment became effective in 1951, when it was ratified by the 36th state, Nevada. Thus the only president to serve more than two terms was Franklin D. Roosevelt, who won election for a third term in 1940 and a fourth in 1944.

In addition to an assured term, the president is protected by various immunities. The Constitution forbids lawsuits or other court actions against the president while he is in office. He can be held legally accountable for crimes or civil liabilities only after his term expires. The Constitution also provides that the president's salary must be fixed by law. And it forbids Congress to make any change during his term of office.

To be eligible for taking the office of president a person must be at least 35 years old and a native-born citizen who has lived in the United States for 14 years. He assumes office by taking this oath: "I do solemnly swear (or affirm) that I will faithfully execute the office of President of the United States, and will to the best of my ability, preserve, protect, and defend the Constitution of the United States." It is customary to have the chief justice of the United States administer the oath.

How the First Presidents Were Elected

The men who devised the Constitution believed that the people could not be trusted to choose presidents wisely through popular election. Therefore they provided that the president should be selected by a method called the *electoral college* (*see* Elections).

Each state was given as many *electors* as it had senators and representatives in Congress. The electors were chosen as state legislatures prescribed. Usually the legislatures named them. Each elector could vote for any two men he chose except that one of the men had to be a resident of another state. The votes were listed and sent to be counted by the president of the United States Senate in the presence of the Senate and the House of Representatives. The candidate who received the most votes became president, and the one with the next highest total, vice-president. (For details of the procedure, *see* United States Constitution, Article II.)

This procedure worked satisfactorily for three elections, but it led to trouble in the fourth in 1800. By this time political parties had formed, and the stronger party in each state chose the electors. It was understood that the electors would vote for their party's candidates for president and vice-president. The Democratic Republicans (forerunners of the present Democratic party) won the election. Their electors duly voted for the party's candidates—Thomas Jefferson and Aaron Burr. Jefferson was supposed to be president and Burr vice-president. But the electors could only *name* the two men without designating the intended office. The result was a tie vote. Following constitutional procedure, the House of Representatives elected Jefferson president. Burr then became vice-president (*see* Vice-President).

Changes in Election Methods

To prevent similar situations in the future, the 12th Amendment to the Constitution was ratified in 1804. It provided that each elector should vote for one man to be president and another to be vice-president. In 1933 the 20th Amendment changed the time of taking office from the old date of March 4 to noon of January 20. It also clarified procedure if no one was qualified to assume office on this date.

Only the 12th, 20th, and 22d amendments have changed the constitutional methods of electinga president. But custom and political practise have brought many other changes. Today the presidential candidates are nominated by their respective political parties meeting in national convention (*see* Political Parties). In each state one party wins the highest popular vote. This means actually that the electors of the successful party are elected; and it is understood that they will vote for their party's candidate. The result is almost the same as that of a national popular elec-

tion. Sometimes, however, the electoral college system has affected the outcome of an election. (For details of such results, *see* Elections.)

General Powers of the President

The Constitution gives many specific powers to the president. Other powers have accrued to the office through laws passed by Congress, through interpretations of laws by the courts, and through the president's position as leader of his political party.

The president is charged with the enforcement of all federal laws and the supervision of all federal administrative agencies. In actual practise, however, these powers are delegated to subordinates. The president's principal helpers are the heads of the executive departments of the government. Together they form a group called the Cabinet (*see* Cabinet). Presidents have always had secretaries and office assistants; and in 1939 this type of help was strengthened by formation of the Executive Office of the President (*see* United States Government).

All these officials are appointed by the president. He nominates all important administrative and judicial officials who are not under civil service (*see* Civil Service). Most major appointments must be confirmed by a majority vote of the Senate. Federal courts have added to the president's powers by ruling that he also has the implied right to remove officials from office. The president, however, may not dismiss an official who performs quasi-legislative and quasi-judicial duties.

The Constitution gives the president power to grant reprieves and pardons to persons convicted of a crime against the United States. This power is denied only in the case of an official convicted on impeachment. In 1865 President Johnson exercised this authority by granting a general pardon (or amnesty) to certain groups of citizens in the South.

Foreign Relations and National Defense Powers

The president exercises far-reaching powers in the field of diplomacy. In most cases he acts through his secretary of state. The president negotiates treaties with other nations subject to confirmation by a two-thirds vote of the Senate (*see* Treaties). He nominates ambassadors, ministers, and consuls to represent the United States abroad. More important, he supervises the entire conduct of the United States in its relations with other governments. He takes the lead in recognizing new régimes or in withholding official recognition. And he determines broad policies, such as the Monroe Doctrine and the Good Neighbor Policy toward Latin America.

Closely related to these powers is the president's authority as commander in chief of all armed services. He appoints all commissioned officers of the Army, Navy, and Air Force. And during wartime he may plan general overall strategy.

The President's Relations with Congress

The president may recommend measures and laws to Congress and adjourn a session if the two houses fail to agree upon an adjournment date. He can call special sessions of the Senate, the House, or both. In addition, he can veto any law passed by Congress, and such a law becomes invalid unless it is re-enacted by a two-thirds vote in each house (*see* Veto). Congress on the other hand has checks upon the president through its power to make laws and to provide or withhold appropriations for presidential measures and for expenses of executive departments (*see* Congress of the United States).

In time of war or national crisis, Congress usually grants emergency powers to the president. These powers include authority to issue orders regulating most phases of national life and war effort, to organize agencies of government, and to make appointments without confirmation.

Both in times of emergency and normal times, Congress may pass a law establishing a policy but leaving the details to be worked out by the president. He then publishes an *executive order* which has the force of law. Such orders include tariff rates established by the president under the Reciprocal Trade Agreements Act, first passed by Congress in 1934.

The president requests a legislative program for the year in his State-of-the-Union message delivered at the opening of each regular session of Congress. His influence on Congress depends largely upon the chief executive himself and the political make-up of the House and Senate. Other messages to Congress, "fireside chats" by radio and television, and personal tours may influence congressmen directly or indirectly through the voters. As head of his party the president may reward or punish congressmen by granting or withholding patronage (politically dictated appointments to office). Many appointments, however, are subject to "senatorial courtesy." This custom prescribes that the Senate confirm appointments according to the wishes of the senator or senators from the state concerned, if they belong to the president's political party.

Salary and Personal Allowances

The first president, George Washington, was paid a salary of \$25,000 a year. The amount increased to \$50,000 in 1873 and to \$75,000 in 1909. Since 1949 the president has been paid \$100,000 a year.

In 1906 Congress provided \$25,000 a year for travel expenses. In 1946 this was increased to \$40,000. In 1949 Congress added an allowance of \$50,000 a year for other expenses. The president can draw upon this \$90,000 merely by certifying that it was spent.

The president also receives many other benefits. The government provides an executive mansion, called the White House, for the president and his family (*see* White House). The Air Force maintains an airplane for his use. He can use Navy ships for sea travel. The government provides a private car for railroad travel; but the president pays the fares for members of his party. Private companies gladly furnish automobiles for use by the president and his family.

Succession to the Presidency

The Constitution provides that if the president dies or is unable to perform his duties for any rea-

HOW THE STATES HAVE VOTED FOR PRESIDENT

STATES	1856	1860	1864	1868	1872	1876	1880	1884	1888	1892	1896	1900	1904	1908	1912	1916	1920
ALABAMA	9			8	10	10	10	10	10	11	11	11	11	11	12	12	12
ARIZONA															3	3	3
ARKANSAS	4			5		6	6	7	7	8	8	8	9	9	9	9	9
CALIFORNIA	4	4	5	5	6	6	1 / 5	8	8	1 / 8	1 / 8	9	10	10	2 / 11	13	13
COLORADO						3	3	3	3	4	4	4	5	5	6	6	6
CONNECTICUT	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
DELAWARE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
FLORIDA	3			3	4	4	4	4	4	4	4	4	5	5	6	6	6
GEORGIA	10			9	8	11	11	12	12	13	13	13	13	13	14	14	14
IDAHO										3	3	3	3	3	4	4	4
ILLINOIS	11	11	16	16	21	21	21	22	22	24	24	24	27	27	29	29	29
INDIANA	13	13	13	13	15	15	15	15	15	15	15	15	15	15	15	15	15
IOWA	4	4	8	8	11	11	11	13	13	13	13	13	13	13	13	13	13
KANSAS	Admitted 1861		3	3	5	5	5	9	9	10	10	10	10	10	10	10	10
KENTUCKY	12	12	11	11	12	12	12	13	13	13	1 / 12	13	13	13	13	13	13
LOUISIANA	6	6	No vote	7	Rejected	8	8	8	8	8	8	8	9	9	10	10	10
MAINE	8	8	7	7	7	7	7	6	6	6	6	6	6	6	6	6	6
MARYLAND	8	8	7	7	8	8	8	8	8	8	8	8	1 / 7	2 / 6	8	8	8
MASSACHUSETTS	13	13	12	12	13	13	13	14	14	15	15	15	16	16	18	18	18
MICHIGAN	6	6	8	8	11	11	11	13	13	9 / 5	14	14	14	14	15	15	15
MINNESOTA	Admitted 1858	4	4	4	5	5	5	7	7	9	9	9	11	11	12	12	12
MISSISSIPPI	7	7	No vote	No vote	8	8	8	9	9	9	9	9	10	10	10	10	10
MISSOURI	9	9	11	11	15	15	15	16	16	17	17	17	18	18	18	18	18
MONTANA	Admitted 1889									3	3	3	3	3	4	4	4
NEBRASKA	Admitted 1867			3	3	3	3	5	5	8	8	8	8	8	8	8	8
NEVADA	Admitted 1864		2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
NEW HAMPSHIRE	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
NEW JERSEY	7	4 / 3	7	7	9	9	9	9	9	10	10	10	12	12	14	14	14
NEW MEXICO	Admitted 1912														3	3	3
NEW YORK	35	35	33	33	35	35	35	36	36	36	36	36	39	39	45	45	45
NORTH CAROLINA	10	10	No vote	9	10	10	10	11	11	11	11	11	12	12	12	12	12
NORTH DAKOTA	Admitted 1889									1 / 1 / 1	3	3	4	4	5	5	5
OHIO	23	23	21	21	22	22	22	23	23	22 / 1	23	23	23	23	24	24	24
OKLAHOMA	Admitted 1907													7	10	10	10
OREGON	Admitted 1859	3	3	3	3	3	3	3	3	3 / 1	4	4	4	4	5	5	5
PENNSYLVANIA	27	27	26	26	29	29	29	30	30	32	32	32	34	34	38	38	38
RHODE ISLAND	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
SOUTH CAROLINA	8	8	No vote	6	7	7	7	9	9	9	9	9	9	9	9	9	9
SOUTH DAKOTA	Admitted 1889									4	4	4	4	4	5	5	5
TENNESSEE	12	12	No vote	10	12	12	12	12	12	12	12	12	12	12	12	12	12
TEXAS	4	4	No vote	No vote	8	8	8	13	13	15	15	15	18	18	20	20	20
UTAH	Admitted 1896										3	3	3	3	4	4	4
VERMONT	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
VIRGINIA	15	15	No vote	No vote	11	11	11	12	12	12	12	12	12	12	12	12	12
WASHINGTON	Admitted 1889									4	4	4	5	5	7	7	7
WEST VIRGINIA	Admitted 1863		5	5	5	5	5	6	6	6	6	6	7	7	8	1 / 7	8
WISCONSIN	5	5	8	8	10	10	10	11	11	12	12	12	13	13	13	13	13
WYOMING	Admitted 1890									3	3	3	3	3	3	3	3
TOTAL	Buchanan 174	Lincoln 180	Lincoln 212	Grant 214	Grant 286	Hayes 185	Garfield 214	Cleveland 219	Harrison 233	Cleveland 277	McKinley 271	McKinley 292	Roosevelt 336	Taft 321	Wilson 435	Wilson 277	Harding 404
	Frémont 114	Douglas 12	McClellan 21	Seymour 80	Various cand 63	Tilden 184	Hancock 155	Blaine 182	Cleveland 168	Harrison 145	Bryan 176	Bryan 155	Parker 140	Bryan 162	Taft 8	Hughes 254	Cox 127

1924	1928	1932	1936	1940	1944	1948	1952	STATES
12	12	11	11	11	11	11	11	ALABAMA
3	3	3	3	3	4	4	4	ARIZONA
9	9	9	9	9	9	9	8	ARKANSAS
13	13	22	22	22	25	25	32	CALIFORNIA
6	6	6	6	6	6	6	6	COLORADO
7	7	8	8	8	8	8	8	CONNECTICUT
3	3	3	3	3	3	3	3	DELAWARE
6	6	7	7	7	8	8	10	FLORIDA
14	14	12	12	12	12	12	12	GEORGIA
4	4	4	4	4	4	4	4	IDAHO
27	29	29	29	29	28	28	27	ILLINOIS
15	15	14	14	14	13	13	13	INDIANA
13	13	11	11	11	10	10	10	IOWA
10	10	9	9	9	8	8	8	KANSAS
13	13	11	11	11	11	11	10	KENTUCKY
10	10	10	10	10	10	10	10	LOUISIANA
6	6	5	5	5	5	5	5	MAINE
8	8	8	8	8	8	8	9	MARYLAND
18	18	17	17	17	16	16	16	MASSACHUSETTS
15	15	19	19	19	19	19	20	MICHIGAN
12	12	11	11	11	11	11	11	MINNESOTA
10	10	9	9	9	9	9	8	MISSISSIPPI
18	18	15	15	15	15	15	13	MISSOURI
4	4	4	4	4	4	4	4	MONTANA
8	8	7	7	7	6	6	6	NEBRASKA
3	3	3	3	3	3	3	3	NEVADA
4	4	4	4	4	4	4	4	NEW HAMPSHIRE
14	14	16	16	16	16	16	16	NEW JERSEY
3	3	3	3	3	4	4	4	NEW MEXICO
45	45	47	47	47	47	47	45	NEW YORK
12	12	13	13	13	14	14	14	NORTH CAROLINA
5	5	4	4	4	4	4	4	NORTH DAKOTA
24	24	26	26	26	25	25	25	OHIO
10	10	11	11	11	10	10	8	OKLAHOMA
5	5	5	5	5	6	6	6	OREGON
38	38	36	36	36	35	35	32	PENNSYLVANIA
5	5	4	4	4	4	4	4	RHODE ISLAND
9	9	8	8	8	8	8	8	SOUTH CAROLINA
5	5	4	4	4	4	4	4	SOUTH DAKOTA
12	12	11	11	11	12	11 1	11	TENNESSEE
20	20	23	23	23	23	23	24	TEXAS
4	4	4	4	4	4	4	4	UTAH
4	4	3	3	3	3	3	3	VERMONT
12	12	11	11	11	11	11	12	VIRGINIA
7	7	8	8	8	8	8	9	WASHINGTON
8	8	8	8	8	8	8	8	WEST VIRGINIA
13	13	12	12	12	12	12	12	WISCONSIN
3	3	3	3	3	3	3	3	WYOMING
Coolidge 382	Hoover 444	Roosevelt 472	Roosevelt 523	Roosevelt 449	Roosevelt 432	Truman 303	Eisenhower 442	
Davis 136	Smith 87	Hoover 59	Landon 8	Willkie 82	Dewey 99	Dewey 189	Stevenson 89	

son, the vice-president shall become president. The Constitution provides that if the vice-president dies or is otherwise unqualified, *either before or after* assuming the presidency, Congress can say who shall hold the office until the next election.

In 1886 Congress passed a law which gave the succession to members of the Cabinet in the order in which their departments were established. In 1947 President Truman signed a new law giving the following order of succession: vice-president; speaker of the House; president *pro tempore* of the Senate (who would have been chosen when the vice-presidency was vacated); and then the Cabinet secretaries in this order—state, treasury, defense, attorney general, postmaster general, interior, agriculture, commerce, and labor.

The Number of Presidents

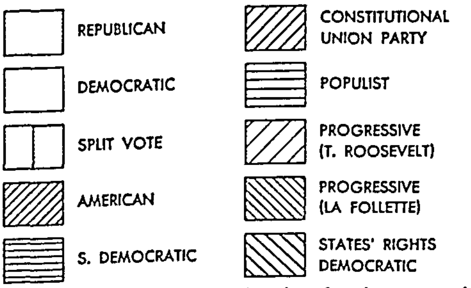
Some writers have mistakenly held that John Hanson of Maryland was the first president of the United States. This confusion arose from the days when the colonies were held together by the Articles of Confederation. At that time the Continental Congress called itself "The United States in Congress Assembled"; and for a time Hanson was president of the Congress. But the office of president of the United States did not originate until the Federal Constitution was adopted in 1788.

Confusion has also arisen over the number of presidents since George Washington. In 1884 Grover Cleveland was elected as the 22d president. In 1888 he was defeated by Benjamin Harrison, who became the 23d president. But in 1892 Cleveland was re-elected. Was he the 24th president or still the 22d?

In 1950 the editors of the *Congressional Directory* decided to count Cleveland as the 24th president in his second term. William McKinley thereby became the 25th president, and so on. (For a table of the presidents, *see* **President** in the FACT-INDEX.)

The chart at the left shows how each state cast its electoral votes in every election since 1856, the first election in which the Republicans nominated a candidate. Eleven Southern states lost their votes during and after the Civil War. The largest electoral vote in history was given to F. D. Roosevelt in 1936.

KEY TO CHART



The chart also shows that in six elections presidential candidates representing minor parties have polled electoral votes. The candidates, the votes they received, and the year are: Fillmore, 8 (1856); Breckinridge, 72, and Bell, 39 (1860); Weaver, 22 (1892); Roosevelt, 88 (1912); La Follette, 13 (1924); and Thurmond, 39 (1948).

PRETENDER. A claimant to a throne, especially an heir of a deposed line, is called a "pretender." In British history the name is applied especially to the son and grandson of the exiled James II. Many English and Scottish nobles remained faithful to this Roman Catholic branch of the house of Stuart. They were called "Jacobites" from the Latin *Jacobus*, for "James."

The deposed king died in 1701. The French court then proclaimed his 13-year-old son, James Stuart, "James III, king of England and Scotland." James failed in an attempt to invade Scotland in 1708 and again failed in 1715. He is called the Pretender or the Old Pretender.

His son, Charles Edward, born in Rome in 1720, is known as the Young Pretender. Because of his charm, he was also called Bonnie Prince Charlie. In 1745 he landed in western Scotland and soon had a Highland army to support him. He invaded England, but retreated when English Jacobites failed to rise to his support. In April 1746 the British crushed his army in the battle of Culloden Moor, near Inverness. Charles fled to the outer Hebrides, where a Scottish girl, Flora Macdonald, disguised him as a woman and guided him to safety. Finally he escaped to France. Long before his death, in 1788, the Stuart cause had ceased to be of importance. (*See also* English History; James, Kings of England.)

PRIMARY ELECTIONS. About the end of the 19th century there developed in the United States widespread hostility to some of the practices of political parties. One of the chief targets of criticism was the system of nominating all candidates for public office by party conventions. Out of this criticism grew the direct primary, or "nominating election." Its aim was to give the voters a fair chance to nominate candidates.

Originally the leaders of each political party met in caucus to nominate party candidates. But beginning about 1828 candidates were nominated by local and national conventions. Many people came to believe, however, that this system gave party leaders too much control over the choice of candidates.

In 1903 Wisconsin led the revolt by adopting a state-wide primary law. The movement spread until today practically all states have adopted primary elections to nominate local, county, and state officers and members of Congress. Details of the system vary, but in most states names of candidates are placed on the ballot by petitions signed by a certain number of voters. Usually nomination goes to the candidate receiving a plurality of votes, but some states require a particular percentage of the vote cast. The primary is the common method of electing party committeemen and delegates to the national conventions. In about one third of the states the primary is also used to express a preference for presidential candidates, but the result of the vote is usually not binding on the convention delegates (*see* Elections).

Some primaries are "open" and some are "closed." At the open primary the voter is given the ballots of all parties and is allowed to mark the one he wishes. Most states use the closed primary. Here an effort is made to restrict voting for party candidates to members of that party. There are different methods in different states. Sometimes the *intention* to support the nominees of a party at the next election determines party membership; or it may be decided by the person's vote at the last primary election; or by his answers to questions which the party prescribes.

The direct primary has not cured the ills of party politics. However, it offers a chance to defeat a plainly unfit candidate or to nominate one who is well qualified.

PRIMROSE. The name primrose is given to many flowers of two different families. The best known are the English primrose, celebrated in poetry and song, and the evening primrose of North America.

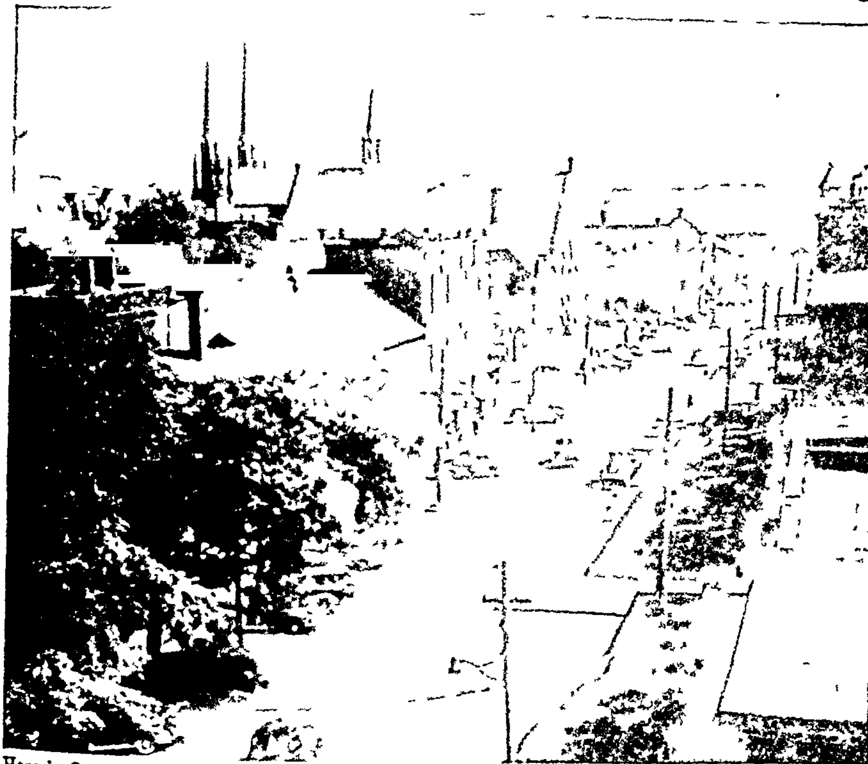
The English primrose is a dainty little flower with a yellow blossom about an inch across. It has five petals and five stamens. It is a spring-blooming perennial. It does not grow wild in America, but related species are cultivated in gardens. The cowslip is one of the primroses (*see* Cowslip).

THE OXLIP, AN ENGLISH PRIMROSE

The oxlip *Primula elatior* is a close relative of the cowslip. It differs from it in having a flat, open corolla. The pale yellow flowers rise from a rosette of fleshy leaves.

The evening primrose grows in dry fields from Labrador to Florida and west to the Pacific coast. It is a biennial, blooming the second year from early summer until frost. The first year it develops a broad, flat rosette of leaves. The second year a coarse stalk three to six feet tall springs from the rosette. The yellow blossoms, one to three inches across, have four petals and eight stamens. They open one at a time at sundown. (For illustration in color, *see* Flowers.) The scientific name of the English primrose is *Primula vulgaris* (family *Primulaceae*); of the evening primrose, *Oenothera biennis* (family *Onagraceae*).

PRINCE EDWARD ISLAND—*The "Garden of the Gulf"*



Here is Queen Street, the main business thoroughfare of Charlottetown, the capital of the province. It ends at the beautiful landlocked harbor. In the left background rise the spires of St. Dunstan's Basilica. Broad, tree-shaded streets lend charm to the city.

PRINCE EDWARD ISLAND. In the southern arm of the Gulf of St. Lawrence lies Canada's smallest and most densely populated province. The Micmac Indians called it *Abegweit*, "The Home Cradled on the Waves." Intensive cultivation has made it known as the "Garden of the Gulf."

The province occupies a charming crescent-shaped island. Its area (2,184 square miles) is only a little more than that of the state of Delaware. It is about 120 miles long and from 2 to 34 miles wide. Northumberland Strait, which is from 9 to 30 miles wide, separates the island from New Brunswick and Nova Scotia to the west and south. Cape Breton Island lies to the east.

Deep bays and their estuaries almost meet across the island, leaving only a narrow isthmus between them, less than two miles wide at some points. Bedeque and Malpeque bays at the west end and Hillsborough Bay at the east end nearly meet and divide the island into three sections. Rivers are short and the tide reaches their headwaters. The Hillsborough River, an estuary of the bay, is the longest. There are no fresh-water lakes. Broad, sandy beaches, backed by low dunes, rim the north shore facing the Gulf of St. Lawrence. This area is a popular summer resort. A 25-mile stretch of beach from New London Bay to Tracadie Bay has been made a national park. At the west end is Green Gables, the white farmhouse made famous by Lucy Maud Montgomery's story for girls, 'Anne of Green Gables'.

Along the south shore, low, crumbling cliffs of red sandstone face Northumberland Strait. The interior is a lowland plain, relieved by a chain of gently rolling hills. Nowhere do they rise more than 450 feet above sea level. The rich, red soil is a sandy clay loam, fertile and easily cultivated. About 90 per cent of the island is under cultivation.

The climate is cool and damp, being tempered by the waters of the gulf. It is uniform throughout the island, since no part is more than a few miles from the sea and there are no high elevations. The average annual rainfall of 39.5 inches is evenly distributed throughout the year. Snows are heavy, totaling 80 inches. Temperatures at Charlottetown range from a mean average of about 18° F. in January to 65° F. in July.

With a fine climate, fertile soil, and long coast line, it is not surprising that the people make their living as farmers and fishermen. There are no minerals, few forests, and manufacturing is confined to canning and preparing food products for export.

The island's high-quality potatoes are famous. Seed potatoes are shipped to growers in Canada and the United States. Hay, clover, oats, turnips, forage beets, barley, wheat, and fruit are raised. Livestock for breeding purposes is shipped to all parts of North America and the United Kingdom—particularly bacon hogs, cattle (the entire island is free of bovine tuberculosis), and horses. Poultry are also raised in large numbers. Dairying and the manufacture of butter and cheese are important.

Prince Edward Island pioneered in silver fox farming. The industry was founded by Robert T. Oulton and Sir Charles Dalton, whose experiments with the breeding of foxes began in the 1880's. Federal and provincial breeders' associations co-operate to improve the quality of the foxes and to market the pelts. Breeding stock is shipped to other Canadian provinces and to many foreign countries. The federal government maintains an experimental

Extent.—North to south, greatest distance 34 miles; east to west, about 120 miles. Area, 2,184 square miles. Population (1951 census), 98,429.

Natural Features.—Lowland country with gently rolling hills; highest point, near Montague, 450 feet; lowest point, sea level; separated from mainland to the south by Northumberland Strait, 9 to 30 miles wide. Malpeque, Bedeque, Hillsborough, Egmont, largest of many bays and inlets. Chief river: Hillsborough.

Products.—Potatoes, hay, clover, oats; milk, eggs, poultry; butter, processed fish, feeds; lobsters, cod, smelts; fox furs.

Cities.—Charlottetown (capital), 15,887; Summerside (town), 6,547.

station at Summerside to study the habits and needs of these animals.

Oysters and lobsters are taken in the island's bays, and from the nearby "Banks" come cod, herring, smelts, and mackerel. Butter and cheese, processed fish, poultry and stock feeds, and fruit and vegetable preparations are the chief manufactures.

Communications are important to an island. A federal government ferry carries railway freight and passenger trains, automobiles, and passengers from Cape Tormentine, New Brunswick, to Port Borden on the island, where connection is made with the railroad and fine highways. An automobile and passenger ferry also operates between Wood Islands and Pictou, Nova Scotia. Daily air service is maintained summer and winter. Ships from other parts of Canada, the United States, and the West Indies call at the fine harbors on the east and south coasts. There are no harbors on the north, where the winds of the gulf pile up low sand bars at the mouths of the rivers and bays.

Cities and Resorts

Charlottetown, the capital of the province, is the only city (population, 15,887). It commands a beautiful landlocked harbor at the confluence of the Hillsborough, Yorke, and Eliot rivers. The Provincial Building has been in use since it was completed in 1847. The Confederation Chamber in this building is preserved as a historical museum. Here was held (1864) the first of a series of conferences which led to the confederation of Canada three years later. A pork-packing plant, lobster canneries, condensed-milk and fox-biscuit factories are among the industries.

Summerside (population, 6,547), on Bedeque Bay, is the center of the oyster fisheries and fox-fur industry. Kensington and Georgetown are popular resorts.

The People, Their Schools, and Government

The people of Prince Edward Island are chiefly of Scottish, English, and Irish descent. About 15 per cent are descendants of the early French settlers known as Acadians, and a few Micmac Indians (257) remain. Ninety-two per cent were born on the island, and 6 per cent in other Canadian provinces. It is the most densely populated of all the provinces (45.1 people to the square mile).

The public schools are supported by the communities in which they are located, with some help from the provincial government. St. Dunstan's University and Prince of Wales (junior) College, in Charlottetown, are the chief centers of higher learning. The island's libraries are among the best in the nation. They are supported by the province on the basis of annual grants from general revenue. A headquarters library distributes books to 24 branches throughout the province. A local committee provides library quarters. Rural schoolteachers are able to borrow book collections for a period of two or three months.

A lieutenant governor, prime minister, and executive council head the government. The legislature consisted of two chambers until 1893, when it was made a single elective assembly. It has 30 members, who serve for five years. They are divided into two groups—15 assemblymen, elected by general suffrage, and 15 councilors, elected by property owners only.

History of the Province

Jacques Cartier visited the island in 1534. He described it as a land of "wonderfully beautiful" trees and rich soil, covered with fruit, berry bushes, and wild grain. "It is the best-tempered region one can possibly see." The island was first settled by the French, who held it for many years as a fishing station. It was known as Ile St. Jean. Its capital, now Charlottetown, was called Port la Joie.

The intercolonial wars between France and England for the possession of North America left the island little disturbed. When the English obtained Acadia by the Treaty of Utrecht in 1713, some of the French moved across the strait to Prince Edward Island, which had remained with France. In 1758 the island was occupied by the British and a partial expulsion of the French took place, corresponding to the exile of the Acadians from Nova Scotia a few years earlier. In 1763 the Treaty of Paris ceded the island with the rest of Canada to Great Britain. At first it was joined to Nova Scotia, but it became a separate colony in 1769. In the winter of 1798–99 Ile St. Jean was renamed for Prince Edward, duke of Kent, who became the father of Queen Victoria. The capital had been renamed previously for Queen Charlotte in 1768.

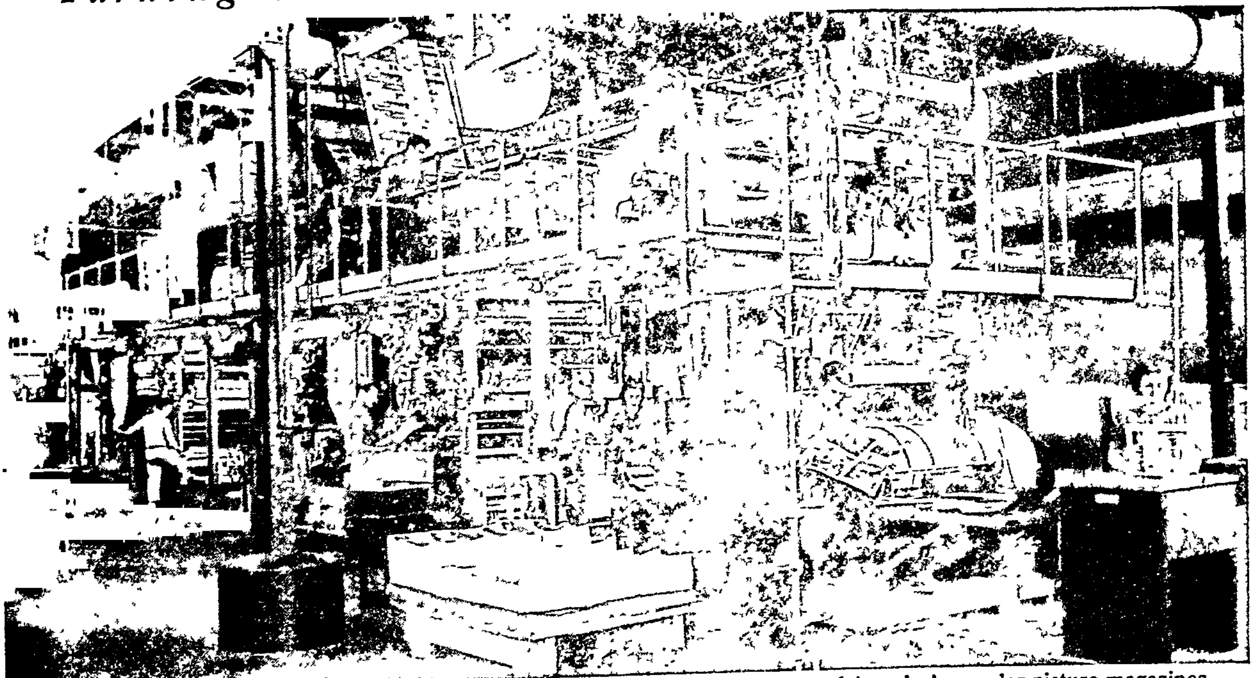
In 1767 the entire island was divided into townships and allotted by ballot to persons in England who had claims against the government. This system of absentee ownership caused discontent among the tenants until Prince Edward Island joined the Dominion of Canada in 1873. The landlords were then forced to sell their holdings to the federal government, which resold the land to the tenants.

British Settlement and Confederation

English, Scottish, and Irish settled all parts of the island. United Empire Loyalists came from the United States at the end of the American Revolution. In 1803–4, Thomas Douglas, earl of Selkirk, settled about 800 Scottish Highlanders on his own holdings on the island. These freedom-loving people engaged with the other Canadian colonies in a long struggle for responsible government by democratic rule (*see* Canadian History). In 1851 the first representative government was formed, with George Coles as prime minister. Resentment over payment of rents to landlords living in England and other economic difficulties led to proposals for a union of the maritime colonies. A convention met in Charlottetown in 1864. It was joined by delegates from Upper and Lower Canada (Ontario and Quebec) and resulted three years later in the formation of the Dominion of Canada. Prince Edward Island did not join the confederation, however, until 1873, when it received assurances that the federal government would take over the railroad and ownership of the land would be vested in the tenants.

The population, after reaching a peak of 109,078 in 1891, declined to 88,038 in 1931 by emigration. By 1951 it was 98,429. (For Reference-Outline and Bibliography, *see* Canada; Canadian History.)

Turning WORDS *and* PICTURES *into* PRINT



This giant press at the Clement plant in Buffalo, N. Y., turns out color pages for one of America's popular picture magazines. It prints four colors on each side of the sheet that runs continuously through the press. The mechanism at the delivery end of the press (right) cuts and folds the sheet into groups of pages, called signatures, ready for binding into the magazine.

PRINTING. Every day around the world millions of words and pictures march into print. They fill newspapers, pamphlets, magazines, and books. They cover advertising displays, signs, and cards, boxes, bags, labels, and wrappers. Pictures and designs decorate countless miles of wallpaper, gift wrapping paper, and fabrics.

The presses that turn out these vast quantities of printed matter are complicated machines. Yet the principle of printing is extremely simple. A child prints when he puts his grimy hand on a clean wall. Using a rubber stamp is printing; so is making designs with a linoleum block. Such blocks and stamps leave their inked marks on paper. They can be used over and over to make exactly the same marks, or impressions. The main job of printing presses, such as the giant shown at the top of this page, is to make thousands or millions of identical inked impressions at a very rapid speed.

Rubber stamps and linoleum blocks are made by cutting away from the surface everything but the design itself. This cutting away leaves the design raised, or *in relief*. Relief designs of letters and pictures form the basis of the most widely used modern method of printing. This method is called *letterpress*, because the raised letters press against the paper to leave their mark.

Letterpress Printing Begins with Type

To form the lines of words for letterpress, printers use type. A piece of type (or more simply, a type) is a small length of lead alloy about an inch high and with a raised letter or other character at one end. (More about type and the cases that hold it is told in the article on Type and Typography.)

The worker who gathers the type for a page of letterpress printing is called a *compositor*. Always in front of him is a typewritten copy of the material to be set up, with "layout" instructions that guide the width of lines. For small or especially complicated jobs the compositor may set the type by hand. He selects individual types from a case and sets them in a metal *composing stick*. The stick is a shallow tray, open on one side and small enough to be held in one hand. One wall can be moved to make the stick wider or narrower, depending upon the width of the line to be set.

Setting type by hand is slow work. The compositor may accidentally drop the stick and jumble, or *pie*, the type. If the type is to be used again, it must be distributed by hand back to the case. After several uses the type face wears down and no longer prints cleanly.

To speed the work and to have new type for each use, most type is set on automatic typesetting machines. Operators punch out their "copy" on keyboards, and the machines respond after a series of operations by casting new type from molten metal. The *Linotype* and *Intertype* machines produce a line of characters in one piece; the *Monotype* line is made up of individually cast types. Type cast by any of these machines can be remelted and re-used. (*See also* Linotype; Monotype.)

One difference between an ordinary typewritten page and a printed page is that the right-hand margin in print is always even. The compositor or the machine operator keeps the margin even by *justifying* each line as he sets it. If the words fail to completely fill the line to its proper width, he inserts extra spaces

SETTING TYPE IN A STICK

From an open case, this compositor is setting type in the "stick" held in his left hand. His "copy" is under his left forearm. The closed cases in the rack hold other sizes and styles of type.

between words or even between letters. If there is nearly enough room for another word, he can insert it by reducing the spaces between words. If more space is wanted between lines, he inserts thin *leads* (pronounced "leds") or thicker *slugs*.

Assembling the Lines of Type

The lines of type are assembled in a long metal tray, called a *galley*. When the galley is full, a few impressions, or *proofs*, are taken on a small proof press. A *proofreader* studies these carefully and marks all the errors that may have been made. Guided by the marked proof, the compositor corrects the type. Another proof may then be "pulled" and sent to the writer or editor for any further changes.

Now the type is ready to be arranged into pages. The compositor transfers the proper number of lines to make up a page from the galley to a hollow rectangular frame, called a *chase*. Then a *lock-up man* locks the pages of type securely in the chase with wooden or metal blocks, called *furniture*, and with metal wedges, called *quoins*.

Turning Pictures into Print

In letterpress printing, pictures—like words—must be turned into relief surfaces, called *relief engravings*. Modern letterpress printing can use all kinds of pictures—drawings, paintings, photographs, diagrams, and "color transparencies." These are transferred to metal plates by photography, so the process is called *photoengraving*. To make an engraving of a simple line drawing (called a *line plate*) the engraver first photographs the drawing. Then he develops the negative and uses it to make a "print" on a sensitized metal plate, usually zinc. In an acid bath, all but the lines of the drawing are eaten away from the surface of the plate. The lines stand in relief, ready for use in printing.

A photograph or painting is made up of shades, or *tones*, rather than lines. To make a photoengraving of a toned picture, the engraver photographs the original through a fine screen, called a *halftone* screen. The screen pattern breaks up the negative into uniformly spaced dots of varying size. The negative is then printed on a sensitized metal plate, usually copper; and in the acid bath all but the dots are eaten away. These dots stand in relief, and in printing they blend together to form replicas of the original tones. The larger dots form deeper tones and the smaller dots, lighter tones. (*See also* Photoengraving and Photolithography.)

The line or halftone plates are mounted on blocks that raise them to exactly the same height as the type. Then they can be held in the chase along with type for printing a page of words and pictures.

Making Duplicates of Type and Engravings

Letterpress printing can take place directly from type and engraving plates. Sometimes it is necessary to make duplicates of these in the form of *electrotypes* or *stereotypes*. One reason is that type wears down on long press runs. Another reason for making several duplicates is that the same page can then be printed on several presses at the same time without setting new type and making new engravings. A third reason is that one type of press, the rotary press, holds its printing surface on a cylinder and thus cannot use a flat chase. Electrotypes and stereotypes can be curved to fit these cylinders. (*See also* Electrotyping; Stereotyping.)

A press chase can be large enough to hold 64 book pages or small enough to hold a single business card. For printing books with average-sized pages, a 32-page chase is often used. The chase, together with its type or plates, is called a *form*. The form prints a single large sheet, which is later folded into a sequence of pages.

Arranging the pages within a form must be done with great care. After the sheet is folded the pages must appear in proper order and with even margins. (*See also* Books and Bookmaking, section "Steps in the Making of a Modern Book.")

Printing by Lithography

Type and engravings, or their duplicates, impress their inked *relief* surfaces on paper. Printers also use a method called *lithography* to transfer inked *plane* surfaces on paper. The method is based on the fact that ink, being greasy itself, will stick to a greasy surface but will not adhere to a water-covered surface.

The word lithography comes from Greek words meaning "stone drawing." Early lithographers (and those who practice it as a fine art today) drew pictures with a grease crayon on a stone surface. The open areas were covered with a thin film of water. Ink applied to the whole surface stuck to the crayon lines only. When paper was pressed down on the stone, it picked up the inked design (*see* Lithography).

For modern commercial printing, a metal plate instead of a stone is used, and the picture is photographically printed on the sensitized surface of the metal. Thus the commercial method is called *photolithography*. The image on the metal is chemically treated to attract ink, just as the crayon lines do. To put words on a photolithograph plate, the "copy" is usually first set in type. A proof of the type is photographed and is thereafter handled in the same way as a picture.

Inked lithographic plates can transfer their impressions directly to paper. Much better results come when a soft rubber "blanket" picks up the inked impression first, then transfers it to paper. This printing process is called *offset lithography*, because the impression is first "offset" on to the rubber.

Printing by Gravure

Besides relief (letterpress) and plane surface (lithography) processes, printers use *gravure*. A gravure plate is the reverse of a letterpress plate. Letterpress prints from a raised design; gravure from a depressed design. Such a below-the-surface design is called an *intaglio*.

LAST-MINUTE CORRECTIONS BEFORE PLATING

This compositor is making final corrections in a form already partially locked up in a special foundry chase. When he has finished, the form will go to the foundry to be made into an electrotype plate.

The commercial method is called *photogravure*, because the original picture is photographically transferred to a sensitized metal surface. A screen is used, as in photoengraving, but it may have a much smaller mesh. An acid bath eats away the design, leaving it depressed as a pattern of tiny pits, or wells. These wells are uniformly spaced but they vary in depth. As in photolithography, words may be photographed from a proof sheet and thereafter treated as a picture. Nearly all gravure printing is done on rotary presses. These use cylindrical printing plates; so the gravure surface is part of a cylinder.

To print, a thin ink is applied to the whole design, filling the wells and covering the surface. Then a "doctor blade" wipes the surface clean. The wells, of varying depth, deposit varying amounts of ink on the paper and thus re-create the original tones of the picture.

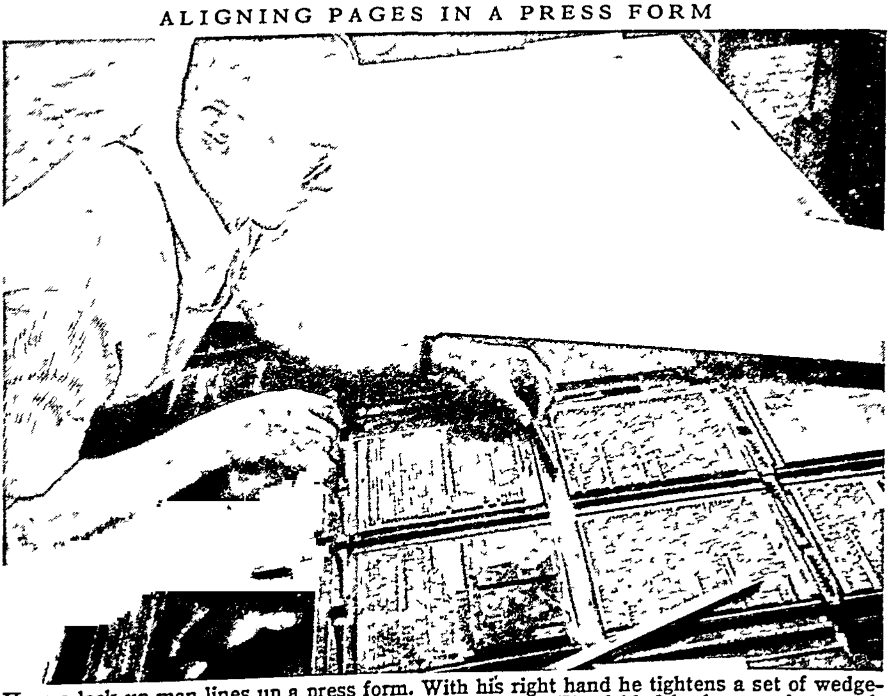
Printing Presses

The main job of a printing press is as its name suggests—to press the inked form and the paper together. Presses actually perform many actions They move the paper along through the whole printing process, print on one or both sides in one or more colors, and sometimes cut and fold the paper.

Letterpress printing has the widest choice of presses. In addition to certain "hand" presses for specialized work, it can use a *platen*, a *cylinder*, or a *rotary* press. (These are shown in the diagrams on a later page.) Except when stone surfaces are used, lithography uses a rotary press. Gravure uses a rotary press exclusively.

The platen press is the type most widely used in school printing classes and in small print shops. The most common design of platen press prints by

ALIGNING PAGES IN A PRESS FORM



Here a lock-up man lines up a press form. With his right hand he tightens a set of wedge-shaped quoins. His left hand holds a piece of furniture. The folded-back paper is a semi-transparent ruled sheet that guides the alignment of pages.

READYING A MULTICOLOR ROTARY PRESS

These men are putting printing plates in position on a multicolor rotary press. Plates on the upper cylinder print one color, and the lower plates print a second color on the same side of the paper.

squeezing the paper between the flat platen and the inked form. Because of the way these two surfaces open to receive the paper and close to print it, the platen press is sometimes called a "clam shell" press. The paper can be fed into the press by hand or by pneumatic suction cups.

The platen itself is a flat steel slab covered with paper board and paper. The top sheet is pulled tight, like a drumhead, and is thus called a *tympan* sheet. This gives the platen a slight cushioning quality as it presses the paper against the ink form. To overcome any irregularities in the height of the type or plates in the form the paper packing can be built up slightly. This adjustment is called *make-ready*. It takes place after the pressman studies a trial printed sheet and sees if any areas have printed unevenly. He then builds up corresponding areas on the platen with thin pieces of paper so that all parts of the form will print with equal pressure. Similar problems of make-ready are also solved on cylinder and rotary presses.

On the cylinder press the printing form is held on a flat bed. The bed itself moves forward under a turning impression cylinder to print a sheet of paper. Then it moves back under inking rollers to get a fresh coat of ink. Meantime the rotating impression cylinder discharges the printed sheet and picks up a blank sheet. Both the platen and the cylinder presses are *sheet-fed*. This means that individual sheets, rather than a continuous roll, or *web*, pass through the press.

The rotary press has one or more sets of two cylinders. The *plate* cylinder holds the curved electrotype or stereotype plates, and the impression cylinder provides the pressure. The paper passes between the two and may be in the form of cut sheets or in a web, or roll. With a continuous web passing between the constantly turning rollers, the press can run very fast. A newspaper press, for example, can make 30,000 or more impressions an hour.

The rotary press is usually a *perfecting* press; that is, two sets of cylinders are arranged so as to print on both sides of the paper as the web passes through the press. When gravure plates are used on web-fed rotary presses the process is called *rotogravure*.

Color Printing

Words are nearly always printed in black ink and pictures usually appear in black and white. Many pictures take on added meaning and beauty when they are printed in two or more colors. To achieve a blend of different colors on a page, there must be a separate plate or form for each color of ink used. The different inks, printed one on top of another, combine to form additional colors. (How the separate plates are made from one original picture is told in the articles on Color and on Photoengraving.) Any of the three processes—letterpress, lithography, or gravure—can be used to print color.

On platen presses, usually only one color is printed at a time. Then the press is cleaned and the second color form with its supply of ink is attached. The one-color sheets are run through again, and so on until the sheet is printed with the maximum number of inks, usually four. Printing four or more inks to create the full colors of the original picture is sometimes called *process* printing. A *multicolor* rotary press has several sets of plate and impression cylinders, each with its own supply of a different colored ink. The web of paper passes from one set of cylinders to the next and emerges fully printed at the end.

Other Types of Printing

Nearly every business, school, club, or organization needs various kinds of printed matter, such as form letters and announcements. A printer could do this work but his service might be too slow or too costly. For quick, cheap printing these organizations have small machines that can be operated by people who are not trained printers.

One of the oldest of these machines is the *stencil* (or *Mimeograph*, from one of its trade names). "Cutting" a stencil means cutting through the thin plastic coat on the stencil sheet with a stylus or on a type-

writer. Then on the machine, ink is forced through the cut-away portions of the stencil to leave an ink impression on paper.

The *hectograph* process is useful when only a few hundred copies are wanted. The material to be duplicated is prepared on ordinary paper with special hectograph ink. The copy is then pressed face down on a gelatin surface. The gelatin absorbs the ink from the paper and holds it as a reverse image of the original. When blank paper is pressed down on the inked gelatin surface, enough ink is released to make an impression. These operations are mechanized in modern hectograph machines.

The *Multigraph* works like a miniature rotary press. Instead of a plate cylinder it has type set in the grooves of a metal drum. Offset lithography methods are also used in office machines. The copy is prepared on a typewriter, which can automatically justify lines (*see* Typewriter). Then it is photographed as an offset plate. Other offset plates can be prepared directly on the typewriter.

Xerography uses a device that prints without pressure. It is based on the fact that certain electrostatically charged powders will stick to a surface with an opposite charge and then will jump to another surface with a higher electrostatic charge. The image on a xeroprinting plate cylinder is so charged and then covered with powder. When the plate is turned toward more highly charged paper, the powder—holding the image—leaps to the paper. The powder stays in place and is heat-bonded to the paper.

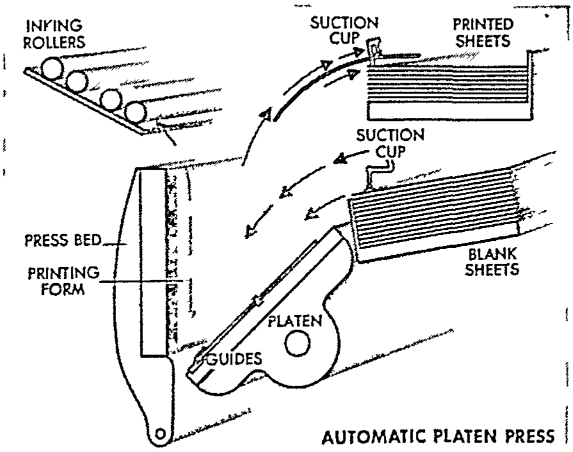
Silk screen printing (or *serigraphy,* "writing on silk") is widely used for commercial and art reproduction work. The silk screen is first covered with wax. The artist makes a design by cutting away the wax and exposing the silk threads beneath. Using the screen as a stencil, he prints the design on paper by forcing pigments through the threads. Multicolor printing can be done by using one screen for each color.

Printing's Long History

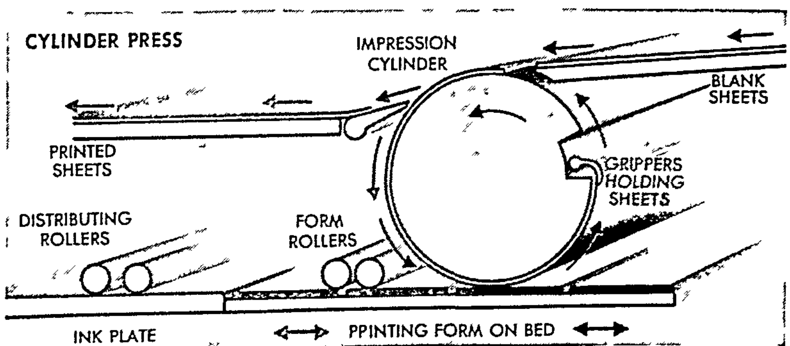
The art of carving relief or intaglio designs for making impressions began in very ancient times. Early artists carved a seal or stamp and pressed it into the wet clay of their pottery, usually to show ownership. Except for clay tablets, the first writing surfaces —papyrus, parchment, and vellum—did not take stamped impressions well. After paper was invented in China about A.D. 105, men carved woodcuts, showing words and pictures. They inked these blocks and pressed them on paper.

One of the earliest known block prints was printed in Japan in A.D. 764. When European merchants be-

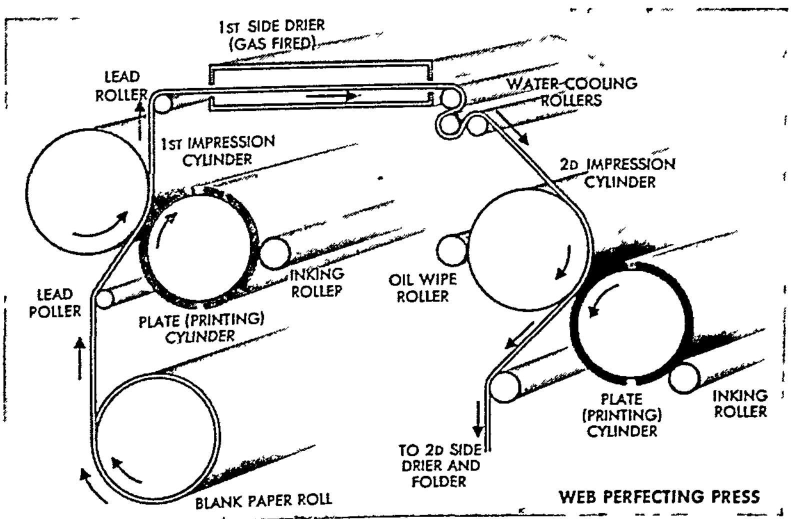
THREE TYPES OF PRINTING PRESSES



This automatic platen press prints by closing the paper between the platen and the form. As the press opens, one set of pneumatic suction cups lifts out the printed sheet and another set inserts a blank sheet. At the same time the inking rollers move down and ink the form.



On the cylinder press the printing form is held on a flat bed. This bed moves under the rotating impression cylinder, which holds the paper, to print. Then it moves back again for another coat of ink from the form rollers. While the form is printing, the form rollers are re-supplied from the ink plate, which in turn is fed by the distributing rollers. While the form is being inked, the impression cylinder discharges the printed sheet and picks up a blank one.



This type of rotary press is called a web perfecting press. It passes a continuous web of paper through and "perfects" it; that is, it prints on both sides. The first printed side is heat-dried, then cooled, before the paper passes between the second set of cylinders. The oil wipe roller prevents the printed side from smudging the second impression cylinder. Additional sets of colored ink rollers and cylinders may be added to this arrangement.

gan importing Oriental goods in the 1300's, specimens of block prints came with the silks and spices. Marco Polo probably brought block prints from China. Europeans first used wood blocks for religious pictures and playing cards. Examples of early religious prints still in existence are the 'Brussels Madonna' (about 1418) and the 'St. Christopher' (1423).

The Chinese had invented movable type about A.D. 1040, but they made little use of it until modern times. The Chinese language has thousands of word-characters, as contrasted to our 26-letter alphabet, so Chinese typography is immensely complicated.

Europeans began printing from movable type sometime before 1450. All the earliest specimens come from the Rhine Valley; and a very strong tradition credits Johann Gutenberg with inventing the process. (*See also* Gutenberg; Type and Typography.)

The oldest known specimen of a book printed from type is the fragment of an almanac for the year 1448. The next oldest printed matter are several examples of certain church certificates, called indulgences. These were intended for use in 1454; the year is printed on them and a space left for the month and day to be filled in with pen. The first complete book to state the year of its printing is a Psalter in Latin, for choir use. This was produced by Johann Fust and Peter Schoeffer, and its last page was set Aug. 14, 1457. Ten complete copies and several fragments survive.

Many pieces of early printing can be assigned no definite date. Some of them are of cruder workmanship than the 1448 almanac. Of the complete books that bear no dates at least one is earlier than the 1457 Psalter. This is an edition of the Bible in Latin, commonly called the 42-line, or Gutenberg, Bible. Most historians accept the tradition that this Bible as well as some earlier pieces are the work of Johann Gutenberg. A few authorities uphold a rival tradition which ascribes the invention of printing to Laurens Coster of Haarlem. Still other historians say that no single man could have conceived the original idea of printing from movable type and carried it out so successfully. (*See also* Books and Bookmaking.)

The 42-line Bible and the 1457 Psalter are products of a highly developed technique. The Psalter is a more elaborate work than an ordinary printer today could produce in a small shop. Its ornamental initials, surrounded by a delicate filigree pattern, are printed in red and blue; the text is in black. The register of these colors, that is, their location on the page, is exact. Products of modern color presses are often inferior in register to the Psalter.

From the Rhine Valley printing spread through Europe with astonishing rapidity. Surviving specimens show that it was introduced into the following countries at least as early as the year indicated: Italy, 1465; Switzerland, 1466; Holland, 1469; France, 1470; Belgium, Austria-Hungary, and Spain, 1473; England, 1476; Denmark, 1482; Sweden, 1483; Portugal, 1487; and Turkey, 1494. Between 1450 and 1500 more than 8 million books were printed. Records exist of 1,125 printing establishments in 259 cities during this time.

Development of the Printing Press

The first presses resembled the cheese or cider presses of the time. They were made of wood and the inked type form was held in a bed. The platen was screwed down to press a moistened sheet of paper against the type. In later designs the platen was held stationary and a movable form was pressed against it. The type was inked by patting it with a brayer daubed in thick printer's ink.

In 1804 the earl of Stanhope, of England, built the first iron press. About the same time hand presses operated by levers instead of screws were built in America. These were similar to the Franklin and Washington hand presses still seen in some small shops. Inking by gelatin rollers was the next advance. Then the first cylinder presses, powered by steam were built in England by two Germans, Frederick Koenig and Andrew Bauer. These were put in service by the *London Times* in 1814. Robert Miehle, an American, brought the multicolor cylinder press to a high degree of perfection in the 1880's.

In 1865 William Bullock of Philadelphia introduced the web-fed rotary press. This was similar to the rotary press of today except that Bullock's machine cut the paper before it passed between the cylinders. Curved stereotype plates came in 1868. Before that, a machine on which the type was locked to a cylinder had been invented by the Hoe brothers—Richard, Peter, and Robert—of New York and their associates. The Hoe Company had taken over the patents of a Boston pioneer, Isaac Adams, and had added many developments to printing. The company was one of the first to build perfecting presses that printed on both sides of the paper in one continuous operation.

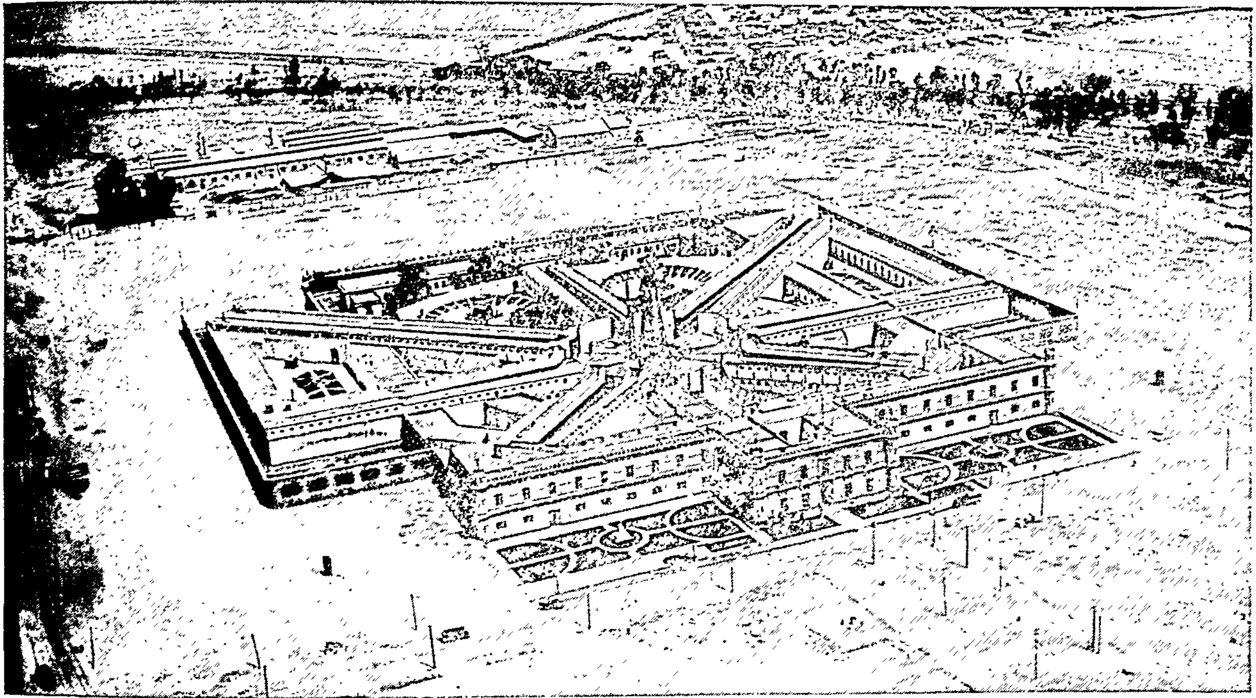
PRISONS AND PUNISHMENTS. As soon as firm governments became established in the world, men began to realize that crime is harmful not only to an individual, but to the state as well. The state imposed certain duties upon its citizens and in return it was bound to protect their lives and their property. The criminal became a public enemy. It was therefore the state's duty to arrest, judge, and punish him.

For ages punishments were inflicted chiefly in the spirit of the old law of retaliation, "an eye for an eye and a tooth for a tooth." While this feeling has not entirely died out in the popular mind, the laws of all civilized states have abandoned the idea of vengeance. Punishments now are imposed to protect society from criminals by putting them out of the way, either by death or imprisonment; to discourage others from committing crimes by showing them the fate that awaits the criminal; and to reform the criminal.

The Use of Torture

Until comparatively modern times, torture was used not only as a punishment but to extract confessions from the accused and to get evidence in legal trials. The practice of torture was supported by Aristotle, the Greek philosopher, and elaborately regulated in Roman law, which became the basis for all the

SUNSHINE AND AIR FLOOD CELLS IN THIS MODERN PRISON



Mexico's model penitentiary at Mexico City has a series of cell houses extending from a central circle like the spokes of a wheel. This construction gives each prisoner plenty of light and air in his individual cell. Guards are stationed in the great floodlight tower in the center and in the other towers seen at various corners of the wall.

gruesome medieval legislation of Italy, Spain, France, and Germany. In England torture was not authorized by common law, but in the days of the Tudors and Stuarts it was practised under royal prerogative. Condemned men were executed in the most painful ways imaginable. Burning at the stake was the penalty for certain offenses as late as the 18th century. At various times criminals were crucified, stoned to death, buried alive, torn apart by wild horses, thrown to wild beasts, or made to suffer other horrible deaths. Frequently prisoners were tortured for days before their execution, which was generally public.

Methods of Execution

In most of the United States, criminals sentenced to death are electrocuted. In some states they are hanged and in a few they are put to death with poisonous gases. In England hanging prevails. Paris still employs the guillotine. Latin American nations use firing squads. In almost all nations shooting is the military method of execution.

In the last century the number of crimes for which death is inflicted has been greatly reduced. Students of criminology have reached the conclusion that it is not so much the severity of punishment which puts a stop to crime as the certainty of punishment. If all criminals felt sure that they would be caught and sent to prison, it would frighten them more than to see a few criminals hanged, while others equally guilty escaped altogether. In 1765 in England there were, according to Blackstone, no less than 160 offenses for which a man might be put to death, extending from the gravest crimes to petty thefts. Today, in nearly all civilized countries, capital punishment (as the death penalty is called) is used for only two crimes—treason and murder in the first degree. A number of nations have outlawed the death penalty in peacetime.

Minor offenses were formerly punished by flogging, branding, and mutilation, which are scarcely less repugnant to modern feeling than the medieval torture chamber. Scolding housewives were punished by the ducking-stool, an instrument something like a long well-sweep by which the victim was repeatedly ducked in a pond. For such offenses as seditious libel, especially in books published without license, giving short weight, and brawling, favorite instruments of punishment in England or the American Colonies were the pillory and the stocks, which pinned the victim's wrists or ankles while he was exposed to derision in a public place. The pillory survived as a legal punishment in Delaware until 1905, and the whipping-post is still employed there. But today these forms of punishment have virtually everywhere in civilization given way to the modern penalties of imprisonment or money fines.

When the practise of inflicting prison sentences first took root, during the 16th and 17th centuries, the condition of the prisoners was deplorable in the extreme. Prisons were dark fever-breeding filthy dens, in which men, women, and children were crowded together without ventilation, and with virtually no food except what friends supplied or the jailers furnished for pay. Scarcely less wretched was the lot of those who were deported to distant colonies and forced to labor on plantations.

The credit for rousing the public conscience to the barbarism of such conditions belongs chiefly to the

Englishman John Howard (1726–1790), whose horrifying pictures of prison life forced a change in the treatment of offenders. Scarcely less influential was the work of Elizabeth Fry (1780–1845), a Quaker preacher, who spent much of her life ministering to unfortunates in prison. A similar work was done in the United States by a group of Philadelphia Quakers, who began agitating for prison reform immediately at the close of the Revolutionary War, and in 1787 founded the parent prison reform society. Their efforts bore fruit before those of the English reformers, so that the United States became the first country to set an example to the world of really humane treatment of criminals. The American prison system, now in almost universal use, embodies two main principles: the separation of prisoners by individual cells, and their employment at some form of labor.

How Prison Terms Can Be Shortened

Today a convict can often shorten his term by good behavior, or upon recommendation by the proper authorities he may be released "on parole." This means that he is freed if he agrees to remain in the same state, to avoid bad habits, and to report at intervals to parole officials. Sometimes "deferred sentences" are imposed; this means sentence is imposed but not enforced so long as the offender's conduct is satisfactory. "Indeterminate sentences," now given in many states, set the term within certain limits, as one to ten years, depending on good behavior and the decision of a parole board.

If it appears that a prisoner has been unjustly convicted, he may be pardoned by the governor of the state. Most states have pardon boards to investigate appeals for pardons and report to the governor.

Young offenders are sentenced to reform schools. Here they are taught trades, and an effort is made to surround them with good influences so that they may return to useful life; but many habitual criminals are found to be "graduates" of reformatories.

Most students of criminology favor changes in the present system. Almost all urge a flexible sentence, with no definite time limit. Psychiatrists on the prison staff would investigate a prisoner's family background and life environment, assign him to his proper group in prison, and then study his mental reactions and conduct. He would be freed only when the psychiatrists decided he was "cured" of his criminal tendencies. Hopeless cases would be confined permanently. Since many become criminals in youth, psychiatrists urge that every effort be made to help first offenders adjust themselves to normal living, perhaps in the home under the direction of medical and court authorities. Similarly, as many mentally backward children become criminals, such children should have proper care. (*See* Mental Deficiency.)

PROHIBITION. From almost the dawn of history, men have made laws to restrict the sale and use of liquor. More than 4,000 years ago, the Babylonians sought to control tavern keepers, and laws to this end were included in the code of Hammurabi.

In America, restrictive legislation on liquor goes back to the earliest Colonial days. Massachusetts Bay Colony in 1633 forbade the sale of "strong water to any Indian." At the instance of Governor Oglethorpe the importation of rum and other spirits into Georgia was forbidden in 1733. In all colonies there were laws for the license and regulation of taverns, import duties, and other measures of control.

With the opening of the 19th century, anti-liquor sentiment grew rapidly; but people generally regarded the liquor traffic as something to be controlled rather than prohibited, and they fought its evils by working for more drastic restrictive laws. The movement for the prohibition of liquor—that is, for the enactment of laws to prevent its manufacture and sale—did not arise until almost the middle of the century. The movement gained momentum in 1851 when Maine passed a state-wide prohibition law, which replaced an earlier (1846) but weaker statute. By 1855, twelve other states had enacted prohibition laws.

Prohibition Sentiment Grows

Political opposition to these laws and the difficulty of enforcing them soon brought about their repeal in most of the states that had adopted them. In many parts of the country, however—particularly in agricultural regions—prohibition sentiment continued to grow. The National Prohibition Party was formed in 1869 to secure state and national legislation against the manufacture and sale of liquor.

The lead in the drive against liquor was later taken by the Anti-Saloon League, which became a national organization in 1895 and changed its name to the Temperance League of America in 1948. Its original purpose was to abolish the saloon. It thus had the support not only of total abstainers, but also of all those who believed that saloons were a menace. The league worked to secure enactment of "local option" laws. These were laws which gave the voters in the villages, towns, townships, cities, or counties of a state, the right to decide by majority vote if liquor should be sold in the political division where the vote was taken.

With prohibition districts thus established, the next step was to secure enactment of state-wide prohibition. In 1913, the league began to work for national prohibition. At this time there were nine prohibition states. Four years later there were 26 states which had adopted total or partial prohibition.

National Prohibition Adopted

In December 1917, after the nation had entered the first World War, Congress passed the Webb resolution to submit to the states a national prohibition amendment. The last of the required 36 states ratified the article Jan. 16, 1919, making the amendment effective one year from that date. The Volstead Act to enforce this amendment (the 18th) was passed Oct. 28, 1919, over President Wilson's veto.

For more than a decade the United States was a prohibition country; then, on Feb. 20, 1933, Congress passed the Blaine resolution to submit to the states

the 21st amendment calling for repeal of the 18th amendment. It was adopted by December. Mississippi, Kansas, and Oklahoma later passed prohibition laws, and many local districts also voted "dry." In 1949 Kansas repealed its state prohibition laws.

Prohibition and Liquor Control Abroad

Though the United States was the leader in both the temperance and prohibition movements, Iceland (1908), Sweden (1909), Greenland (1918), and Finland (1919) preceded it in enacting national prohibition. Sweden voted repeal in 1922, Finland in 1932, and Iceland in 1933.

Other countries have moved along the line of increased control and taxation of the liquor traffic, rather than prohibition. Great Britain has limited the number of hours during which liquor can be sold each day. In Turkey, Switzerland, Russia, and some of the Canadian provinces, the sale of spirits is a state monopoly. In Sweden and Norway spirits may be sold only by companies licensed by the government which then receives a portion of the profits. In Sweden consumers are allowed to purchase only a limited amount monthly. (*See also* Temperance; Woman's Christian Temperance Union.)

PROMETHEUS (*prō-mē'thūs*). Greek myths tell us that when man was created, gigantic Titans still lived on the earth. One of the Titans was Prometheus, whose name means "foresighted." According to some legends, Prometheus himself molded man out of clay.

Zeus thought man a wretched creature; so he decided to destroy him and people the earth with a nobler race. Prometheus, in pity, stole fire from the sun and carried it to earth. With this gift man was able to make weapons and tools, and civilization began.

Zeus was enraged at being tricked, and he had Prometheus chained to a cliff above the sea. Each day an eagle devoured his liver; each night the liver grew again. For ages the torment continued; but Prometheus remained defiant. At last Zeus allowed Hercules to kill the eagle and set Prometheus free.

The Athenian tragedian Aeschylus told the story of Prometheus in a great trilogy. Of this only one part, 'Prometheus Bound,' has survived. Shelley wrote two fine poems on the subject. Both represent Prometheus as the benefactor of man. But the earliest legends claim that Prometheus brought man more evil than good.

PRONOUN. Pronouns—words used in place of nouns—save us a great deal of wearisome repetition in writing and speaking. Instead of naming over and over again the persons or things we are talking about, we use such short words as *you, he, she, it, them,* etc.

The most important kind of pronoun is the *personal* pronoun. A personal pronoun indicates grammatical person by its form alone; as, *I, we, you, your, them, it.* In grammar the term *person* means the property of showing whether a word refers to (1) the speaker, (2) the person or thing spoken to, or (3) the person or thing spoken of. The word is thus said to be the first, second, or third person; as first person, *I;* second person, *you;* third person, *he.* Other kinds of pronouns are also said to be in the first, second, or third person, according to their meaning in a sentence. For example, the pronoun *who* is in a different person in each of the sentences that follow: "I *who* speak unto you am he" (first person); "You *who* listen must decide" (second person); "The boy *who* works will succeed" (third person). The personal pronoun, however, is the only kind that shows grammatical person by its form, when standing alone. Besides person, pronouns also have the other properties which belong to nouns; *gender, number,* and *case* (*see* Nouns).

Other important kinds of pronouns are the *interrogative,* the *demonstrative,* and the *relative* or *conjunctive.* An *interrogative* pronoun is a pronoun used to ask a question; as, "What is that?" A *demonstrative* pronoun is one that points out some particular person or thing; as *this, that.* A *relative* or conjunctive pronoun is a pronoun used to join a clause to a substantive; as, "It's a long lane *that* knows no turning." *Who, which,* and *that* are the most common relative pronouns. (It should be noted, however, that each of these words has other uses.)

The "How" of "Who," "Which," and "That"

The relative pronoun *who* should always be used to refer to persons; the relative pronoun *which* should always be used to refer to things or ideas; the relative pronoun *that* may refer to either persons, things, or ideas. A relative pronoun has two uses in the sentence; as a connective it joins its clause to its antecedent, that is the word to which it refers; as a pronoun it is used in this clause like a noun. In the sentence above, the relative pronoun *that* joins the clause "that knows no turning" to the pronoun *it,* and is used as the subject of the clause. If in doubt as to the use of a relative pronoun in its clause, substitute the antecedent, making the clause a separate sentence; as, "The boy *who,* we thought, was good for nothing became a daring aviator"; or "The boy *whom* we thought to be good for nothing became a daring aviator." In the first sentence *who* is subject of the clause, and *we thought* is thrown in parenthetically; in the second sentence *whom* is subject of the infinitive phrase *to be good for nothing,* and with it is used as the direct object of the verb *thought.* This is proved by substituting the antecedent *boy:* "The boy, we thought, was good for nothing"; "We thought the boy to be good for nothing."

Different Forms of Pronouns

Five personal pronouns, and the relative or interrogative pronoun *who,* each have separate forms for the nominative and the objective cases, as follows: *I, me; he, him; she, her; we, us; they, them; who, whom.* Also the old-fashioned forms *thou, thee; ye, you* are still occasionally used. They also have *possessive* forms, which are sometimes called possessive adjectives; as, "*My* book, *your* dog, *his* duty, *their* pleasure," etc. Some of the personal pronouns have separate possessive forms which are used when the pronoun is to stand alone; as *mine, yours, hers.*

The declensions of the personal pronouns are as follows:

	First Person			
	Singular			*Plural*
Nom.	I			we
Poss.	my, mine			our, ours
Obj.	me			us
	Second Person			
	Singular			*Plural*
Nom.	you (thou)			you (ye)
Poss.	your, yours (thy, thine)			your, yours
Obj.	you (thee)			you
	Third Person			
	Singular			*Plural*
	Masc.	Fem.	Neut.	All Genders
Nom.	he	she	it	they
Poss.	his	her, hers	its	their, theirs
Obj.	him	her	it	them

The relative pronoun *who* has the same forms for both singular and plural: nominative, *who;* possessive, *whose;* objective, *whom.* The only other pronouns commonly inflected are *this* and *that,* which have as plural forms *these* and *those.*

Some difficulties in the use of pronouns arise from the failure to choose the right case-form, and from the failure to make a pronoun agree with its antecedent in number. The case of a pronoun is not determined by the case of its antecedent, but by its own use in the sentence (as we have seen in the examples given in the fourth paragraph of this article). It should be clearly understood that the case to be used when a sentence element is compound (*see* Sentence) is the same that would be used if the pronoun stood alone. Many people who would never say "*Me* did it" or "He brought it to *I*" will say "John and *me* did it" or "He brought it to John and *I*," instead of "John and *I* did it" and "He brought it to John and *me*."

The number and gender of a pronoun are determined by the nature of its antecedent. If the antecedent is of common gender, the masculine pronoun is used; as "*Each* of the children held out *his* hand." *Each, every, either, neither*, though they suggest always more than one, are singular when used alone or with singular nouns, since they always mean *one at a time.* Therefore singular pronouns should be used referring to them. In the sentence above, for example, "Each of the children held up *their* hands" would be incorrect.

Pronouns that Play Many Parts

Since pronouns represent persons, things, and ideas, without naming them, one pronoun may take the place of many different nouns. Hence in using them great care is necessary to make the reference of each pronoun immediately and perfectly clear. The pronouns *this, he, it,* and *which* are especially apt to be used indefinitely.

The correct use of pronouns is one of the surest marks of the careful writer and speaker. Probably the majority of people make errors in the use of these common words every day of their lives. Some of the mistakes to be guarded against are illustrated in these sentences:

"John was *hungry,* but *it* did not distress him so much as *it* did Frank." *It* is here used without a grammatical antecedent. The correct form would be: "John was hungry, but he was not so much distressed as Frank was."

"I can spell better than *him.*" *Him* is incorrectly used for *he.* The nominative form is required, as the subject of the verb *does,* to be supplied.

"*Those* kind of books doesn't interest me." The pronoun should be in the singular, *that,* because it modifies the singular noun *kind.*

"Give me *them* skates." *Them* is a personal pronoun and cannot be used as a demonstrative pronoun to modify a noun.

"She is a girl *who* I know you will like." *Who* should be *whom,* since the pronoun is used as the object of the verb *will like.*

"She is a girl *whom* I know will make good." *Whom* should be *who,* as the subject of the verb *will make.*

"The tree lost *it's* leaves." *It's* for *its.* Notice that the possessive forms *hers, its,* and *theirs* do not have the apostrophe before the *s.*

PROPHETS. We commonly think of a prophet as one who foretells future events, but as used in the Bible the word has a deeper meaning. In the Bible a "prophet" is one who speaks for God. Hebrew prophecy is sometimes said to begin with Moses, who in after-times was regarded as the first and greatest of the prophets. Others regard Samuel as the first of the prophets.

In a special sense the title belongs to those great Hebrew reformers and leaders who, in times when the people of Israel had fallen into evil ways, when they had given themselves up to idolatry or to the pursuit of material things, sternly and fearlessly rebuked them; or, in times of great national disaster, strengthened their faith by assuring them of God's mercy. Such a prophet was Elijah, who battled for Jehovah against the priests of Baal, and is represented as being carried up to Heaven in a chariot of fire, his mantle falling upon Elisha, his successor.

Later we find a succession of inspired leaders, who were writers as well as teachers and men of action, and whose words have come down to us in those parts of the Bible known as the Prophets. The first of these "literary prophets," as they are sometimes called, was Amos, a simple herdsman from Tekoa, who dared to denounce the men of wealth and power, living in luxury built upon the poverty of the people. Then came Hosea, pleading fervently with the people to remain faithful to Jehovah; and Isaiah, with his sublime vision of the day when the God of Israel should be worshiped by all the world.

Another great prophet was Jeremiah, who arose in the dark days before the Babylonian conquest. He was hated because he announced the impending doom of Judah, and was held to be a traitor because he set loyalty to God above loyalty to king and country. Jeremiah was followed by Ezekiel, who was among the captives carried to Babylon. Like other prophets, he was stern in condemning the wickedness of his nation, but he likewise brought consolation by picturing the new life that Jehovah would breathe into the dry bones of Israel.

The prophet Daniel is the hero of the biblical book which bears his name. Carried captive from Jerusalem to Babylon, he won the favor of King Nebuchadnezzar through his wisdom and ability to interpret dreams, and became one of the highest rulers in the

THE 'FRIEZE OF THE PROPHETS'

These figures are from the 'Frieze of the Prophets' by John S. Sargent in the Boston Public Library. They represent, from left to right, Amos, Nahum, Ezekiel, and Daniel. One of the most ambitious paintings by this famous American artist, the frieze has won high rank among the works of moderns who have dealt with sacred subjects.

Babylonian kingdom. When "Darius the Mede" captured Babylon, Daniel continued in high position until jealous princes contrived to have him thrown into a den of lions, where he was miraculously preserved from death.

The "Law" and the "Prophets" are two great divisions of the Old Testament as arranged by the Jews. The Law comprises the five books of Moses; and the Prophets consists of the "major prophets" — Isaiah, Jeremiah, and Ezekiel —and the 12 "minor prophets" (so called because of the brevity of their works)—Hosea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Zephaniah, Haggai, Zechariah, and Malachi. The remaining books are classed as "Hagiographa" or "Holy Writings." The Book of Daniel is placed in the Jewish Bible in this last group. The New Testament speaks of certain inspired evangelists as "prophets." They ranked at the time next to the Apostles. (*See* Bible; Jews.)

PROTECTIVE COLORATION. It seems plain that the most useful coloring for an animal whose life is spent in trying to avoid dangerous enemies would be the one in which it could least easily be seen. Countless races of animals have gradually obtained such coats—sometimes in amazing perfection. The most unmistakable examples are to be found among the most helpless—those who have little or no other means of defense. This seems to show that it is by this "safety first" feature that they have managed to continue to live in a world of merciless warfare.

Almost all the small swimming creatures in the sea and the fry of many fishes are transparent, so that they are quite invisible in water; a ribbon-shaped baby eel, for instance, is as clear as glass (*see* Eel). All full-grown fishes are dark on the back and light underneath, which makes them hard to see from above against the dark water, or from below against the light from the sky. Inshore water creatures, such as the anemones, are the color of mud when their tentacles are withdrawn. The ground-running insects, and bigger things in open spaces, such as the western horned toads, are the color of soil or sand and easily overlooked. The same is true of the hosts of insects that live and feed amid the foliage of trees and bushes or in the grass, matching it by their green or green-mottled coats. Try to find a noisy katydid in an apple tree, and you will appreciate the difficulty of the search.

The Hunters and the Hunted

But, you may say, birds, wasps, and other hunters catch these hiders every day. So they do, but not so easily or numerously as they would if their captives showed themselves scarlet on the ground or golden amid green foliage; and, furthermore, their "disguise," so to speak, is serviceable only so long as they keep still. The wings of the oriental leaf butterfly are gaily colored on the upper surface. But when the insect alights and folds its wings together above its back, their streaked brown undersurface looks so like leaves that the sharpest-eyed natives pass it by unnoticed. Many a person has been surprised to have what seemed a scale of bark on a tree trunk spring into color and flutter away as a moth. So long as such a creature is motionless its similarity to what it rests upon keeps it fairly safe, but the moment it moves it is seen. In some young animals, for instance whippoorwill chicks, the in-

SOME EXAMPLES OF NATURE'S CAMOUFLAGE

The Nassau grouper, like some other tropical fishes, turns dark when he is alarmed (left) and makes for a shadowy hiding place where he may escape observation. Normally his markings are distinct (right) and attract the notice of his enemies.

stinct to remain still is so strong that you may pick them up from the woodland floor—if you can find them.

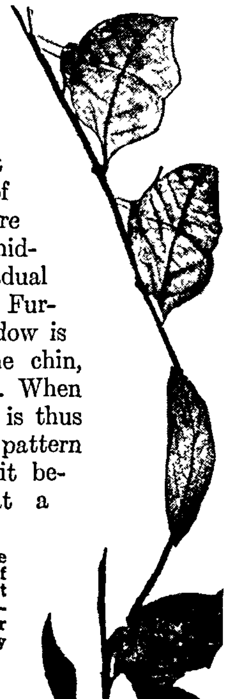
Protection Suited to the Need

This brings out an important point, namely, that in most cases the "protected" animal is in less danger when it is wide awake and active. Its greatest need for color safety comes when it must rest or sleep or care for its young. This last point explains why it is that the female of so many kinds of birds wears a very plain dress while her mate is gaudily feathered. The scarlet tanager, the blackbirds, the grosbeaks, and the indigo bird are familiar American examples. The gay fathers of the families can take care of themselves pretty well, for they are free to fight or flee when danger threatens; but the mothers must sit steadily on their nests, where they would quickly be seen and pounced on by some prowling killer were they wearing bright colors. If this is true of those mentioned, which nest under the cover of leaves, how much more is it true of those, like the killdeer, whose nest lies on open ground. Not only does the mottled back of the sitting mother in such cases so blend with the earth and weeds about her that she usually escapes notice, but even her brown eggs are all but invisible when exposed in her absence. Such enemies as find the nest are probably guided by smell.

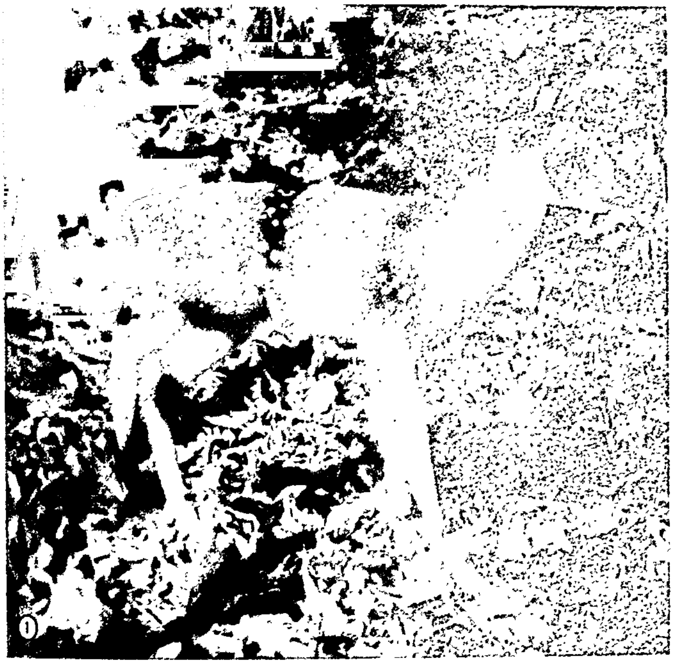
The grass-frequenting sparrows are streaked dark brown and buff or gray, like the dry grass in the fields. The bitterns are more *broadly striped*, like the cattails and sedges of the marshes. The grouse and woodcock are mottled brown and buff like the dead leaves of the forest floor.

Shadings and Spotting

Nature has gone even further than this. Artists have long known how to make objects stand out on the canvas by shading the under side to imitate a shadow thrown by a solid figure. The artist-naturalist Abbott Thayer has pointed out how the exact opposite of this principle is applied to land animals as well as to fish, causing them to become inconspicuous by destroying the appearance of shade on their underparts. This is brought about by their being colored lighter below, in exact proportion to the amount of shade received; so that they are practically pure white on the middle of the belly, with a gradual change to the dark upper parts. Furthermore, wherever else a shadow is thrown, as by the bill or the chin, that spot is colored much whiter. When the solid appearance of a bird is thus destroyed, if its color and pattern are those of its background, it becomes absolutely invisible at a



Can you find the stick insect at the lower left, and the seven Indian leaf butterflies among the real leaves at the right? Imitation is one of nature's most successful devices for protecting insects against discovery by their enemies.



PROTECTIVE COLORATION IS THE DEFENSE OF THE HELPLESS

1. A fawn is the color of fallen leaves. Its white spots look like patches of sunlight. Dark bands on its body blend with the shadows cast over the ground by the woodland trees. 2. Three kinds of caterpillars are crawling on these maple leaves, but a passing bird would have trouble finding them. Can you find the three? One is at the upper left, one at the lower right, and one about in th[illegible] of the picture. 3. The mother spruce grouse crouches on her nest among the leaves of the forest [illegible] Behind her is a cluster of scarlet bunchberry.

SURVIVAL BY IMITATION (MIMICRY)

1. The bumblebee moth (upper) and a true bumblebee light on a petunia. No bird wants to be stung by a bumblebee, and it avoids the moth as well. 2. Weed fish in the Sargasso Sea are almost invisible in drifting seaweed. 3. The stick caterpillar, or measuring worm, reaching from one twig to another, looks just like the bare twigs. 4. Tree hoppers mimic thorns. The "hoppers" on these rosebush twigs—one on each twig—are the thorns with legs. 5. Caddis fly larvae live on the bottoms of streams. They cover their soft bodies with twigs and grains of sand and so escape the notice of their enemies.

HORNED TOAD IN A GRAVEL BED

This horned toad was lying in a dry river bed in the Arizona desert. Had he not moved his flat body just in time, the photographer would have stepped on him. The reptile is misnamed, for he is a lizard rather than a toad. Notice his spines.

around the neck of the kingfisher and the mallard duck. Such marks seem to cut off the head of the bird, or to break up the bird into several pieces, thus destroying its continuity of form. In this way the eye of the enemy is attracted to some one part rather than to the bird as a whole, and it appears like something else. Both of these principles were used extensively during the two World Wars, under the name of "camouflage," to conceal large guns, battleships, motor trucks, and airplanes. Contrasting spots and stripes painted on their sides were the commonest patterns

Banner Marks in Animaldom

A third method of protective coloration is accomplished with "flash colors" or "banner marks." It is exemplified by such conspicuous marks as the white rump of the flicker, or the white outer tail feathers of the meadowlark and other birds—marks which can be concealed or displayed at will. The white rump of the flicker, for instance, is very conspicuous in flight and naturally becomes the target for any pursuing hawk. When the flicker claps up against a tree, however, this spot disappears, and the hawk is sufficiently confused to permit the flicker to escape. The white tail or "flag" of the mother deer

short distance. This principle of protective coloration is called "countershading."

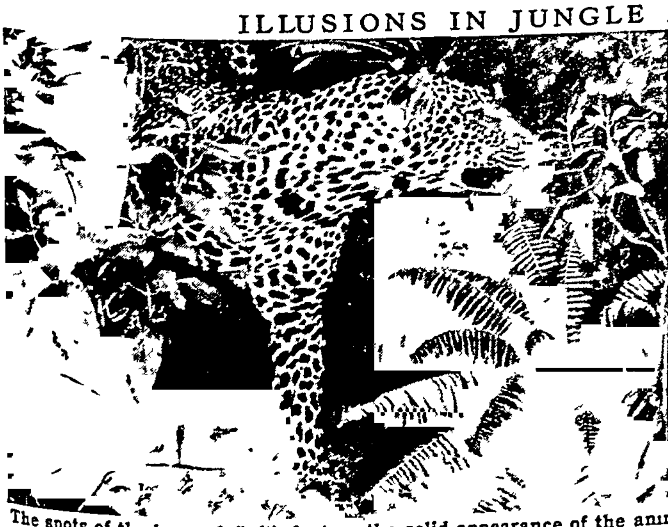
A very different effect is achieved by so-called "ruptive marks." They consist usually of two or three conspicuous black and white stripes parallel to one another. Examples of this pattern are found in the black bands across the white breast of the killdeer and the white ring around its neck; and also that

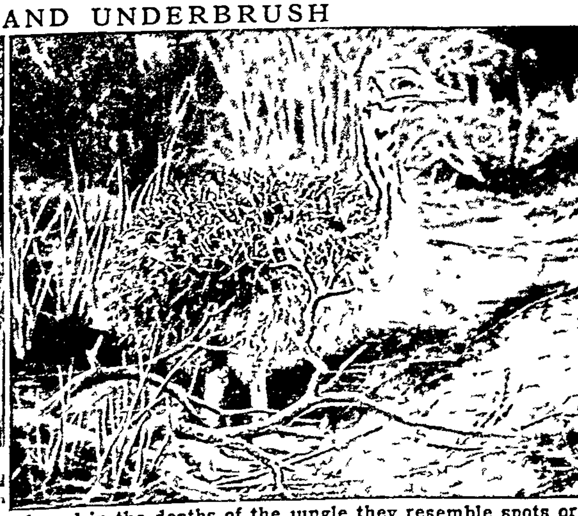
leads many a wolf off on a futile chase, while the helpless fawn hides safely in a near-by thicket.

Masks Used for Attack

The capture of victims by ambush is common among beasts of prey, and the use of color concealment is used by the hunters as often as by the hunted. From the mud-colored crab in the eelgrass to the weed-grown turtle; from the alligator that looks like a

ILLUSIONS IN JUNGLE AND UNDERBRUSH





The spots of the leopard (left) destroy the solid appearance of the animal, and in the depths of the jungle they resemble spots or streaks of sunlight passing through foliage, or reflected from leaves. The baby ostrich (right), when he crouches on the ground, looks like a tumbleweed. The streaks on his neck serve the same purpose as the leopard's spots.

floating log, to the tiger, his stripes matching the streaks of sunlight and shadow among the tall grass; all are lurking until some unsuspecting victim comes near enough to be leaped upon. With no other dress could the ambush succeed.

PROTEINS (*prō'tē-ĭnz*). In order to grow and repair parts that wear out, every plant, animal, or microbe must have a constant supply of food. Among the foods must be the kind known as proteins. These are needed because the bodies of plants and animals are made of cells, and the cells are made of a jellylike substance called protoplasm. Protein foods are the only sources of certain materials needed to make protoplasm. This fact explains why proteins were given their name. The word protein comes from two Greek terms which mean "of first importance."

The special materials which proteins alone supply are all compounds that contain nitrogen. Other foods such as sugars, starches, and fats do not have the nitrogen compounds needed for protoplasm. Most proteins also contain sulphur and small amounts of phosphorus. This combination of elements produces very complex materials. Every particle (or molecule) of one well-known protein is made of 2,165 atoms. Another, somewhat more complex, contains 2,291 atoms.

Proteins are made by cells of green plants that live either on land or in water. The plants begin by combining carbon, hydrogen, and oxygen. Then they add nitrogen to certain compounds to make amino acids. Amino acids then are combined again, with sulphur and phosphorus, producing proteins. If the process is carried still further, proteins are combined with nonproteins. Among the materials produced are the compounds that make up chromosomes and control heredity (*see* Cell; Heredity).

Animals secure protein foods by eating plants. Digestion breaks the proteins down into amino acids, which then are recombined into proteins different from those of plants. These new proteins also seem to differ slightly in different kinds of animals.

Well-known plant sources of protein foods used by human beings include wheat, corn, oats, peas, beans, lentils, and nuts. Good animal sources of protein include fish, lean meat, milk, cheese, and eggs.

Since most animal proteins are now expensive, scientists constantly experiment with methods to reduce their cost. One of these methods is to feed livestock and poultry efficiently so they turn as much food as possible into protein instead of wasting it. Another method is to increase the amount of human food produced in the sea, where vast amounts of protein made by plants have never been utilized. Another method employs yeast plants, which make protein from waste materials or crude molasses. This protein then can be fed to poultry or livestock, thus increasing their production of "life-building" substances suitable for human food.

PROTEUS (*prō'tūs*, or *prō'tē-ŭs*). The Shepherd of the Deep lay at noon in his hollow cave by the ocean's shore. All about him slumbered the well-guarded sea calves (or seals, as we should call them) which the sea-god Poseidon (Neptune) had entrusted to his care. But four of his flock had secretly been slain and in their skins King Menelaus and three of his trusted followers lay hidden. These survivors of the great Trojan War had come to discover why the contrary winds kept them from their far-distant homes.

When Proteus had counted his flock and had lain down to rest, Menelaus and his men threw off the skins and seized him. Then Proteus changed his hair into a mane and his body became a raging lion. But his captors did not relax their grasp for they knew his cunning wiles. Then he sought to writhe out of their hands as a snake. Next he became a leopard, and then a fierce wild boar. Even when he took the shape of running water and of a tall and flowering tree, they held him fast.

At last Proteus wearied of the struggle. He resumed his proper form and told Menelaus how by sacrifice he might appease the wrath of the gods and be granted favorable winds to waft him homeward. When questioned further he told how Agamemnon, the brother of Menelaus, had met a treacherous death and how the other leaders of the Greeks had fared. Then the Greeks released him and he plunged into the depths of the sea.

Proteus was one of the lesser divinities that followed in the train of Poseidon and perhaps typifies the ever-changing aspect of the sea. His name has given us the adjective "protean," meaning "variable."

PROTOPLASM. When we ask what living things are made of, the answer is *protoplasm*. This jellylike substance gets its name from two Greek terms (*protos, plasma*), which mean "first form." The first things that ever lived were tiny lumps of protoplasm. Today this material makes up plants, animals, and creatures that may belong to other kingdoms.

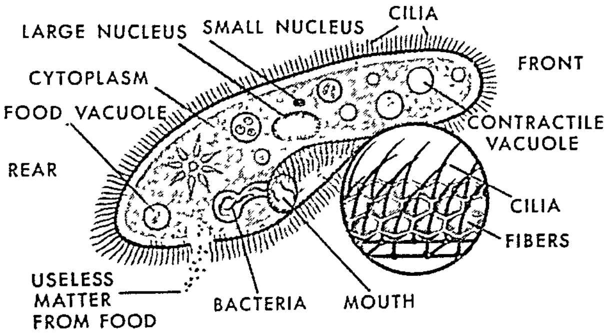
Although protoplasm looks like jelly, it seems to be a combination of watery liquid, droplets, tiny bubbles, and fibers made like mineral crystals. As long as protoplasm is actively living, these materials shift and change. The droplets and bubbles grow larger or smaller, and the fibers thicken, stretch out, or pack closely together. Then they begin to spread out, allowing the watery liquid to flow into spaces between them. When living things rest, however, their protoplasm changes more slowly. In things such as seeds, which lie months or even years without growing, protoplasm becomes dry and hard.

Chemically, protoplasm is made of carbon, hydrogen, oxygen, nitrogen, phosphorus, and several other simple substances, or elements. They are joined together in compounds which may be simple, like water, or may be very complex. Some of the compounds in protoplasm contain as many as 2,000 atoms belonging to five or six different elements. No one has yet discovered how all these atoms are arranged in a single particle, or molecule. There is no doubt, however, that these complex molecules are very important. So is the way they are built into liquids, droplets, bubbles, and fibers. These features help protoplasm do the things that are necessary for life. (*See also* Cell; Life.)

PROTOZOA. If you dip a glass of water from a stagnant pond and look through it toward the light, you may see a host of creatures so small that they look like whitish haze. They belong to the group (or phylum) called *Protozoa*. The name is made from two Greek terms that mean "first animals."

The protozoa were given this name because they are the simplest members of the animal kingdom. Although each protozoan is a complete animal, it is made up of only one cell. That cell performs all the functions of living, from moving and securing food to producing young ones (*see* Life).

HOW THE SLIPPER ANIMAL LIVES



This single-celled animal swims to find food such as bacteria by waving its hairlike cilia. The cilia sweep food into the mouth, which is a hole at the end of a deep, funnel-like groove. A separate picture shows the fibers which move the cilia. The food then passes into clear round spots called food vacuoles, where it is digested. Bubblelike contractile vacuoles collect waste matter from the food. From time to time the vacuoles contract and shoot the waste matter out of the cell.

Various Kinds of Protozoans

Although all protozoans consist of single cells, those cells take many different forms. Some are soft and change shape as they creep about and seek food. Other protozoans build shells of limy material or mud grains. Some have delicate, glassy frameworks that suggest the ornaments hung on Christmas trees. Members of two large groups have no hard parts; yet they grow in definite shapes and develop many special structures. These include stalks, mouths, and hairs or lashes that are used in swimming and catching food.

Protozoans live in a great variety of surroundings. Some make their homes in fresh water, but others creep or drift in the sea. Great numbers live in the soil. Many live in the bodies of insects, digesting food which the insects eat but could not use without help from these protozoans. Other one-celled animals are germs, which cause diseases such as malaria and sleeping sickness.

Two Familiar Protozoans

One of the commonest protozoans is the *amoeba*. It is found in fresh water and in soil on every continent except Antarctica (*see* Amoeba). An amoeba moves about and gathers food by extending the soft, jellylike substance in its cell to form *pseudopods* (false feet). When a pseudopod touches food, the soft body flows around it.

Another common protozoan is the *paramecium*, often called the "slipper animalcule" because its shape suggests the sole of a slipper. It has a funnel-shaped groove on one side and its surface is covered with *cilia*, which are tiny hairlike structures that move to and fro. Cilia on the body enable the paramecium to swim, while those in the groove direct food particles to the mouth. There they go into the cell and are digested, as shown in the picture on this page.

Protozoans That Build Rocks

The protozoans that build shells are called *foraminifera* because their pseudopods extend through small openings, or foramina. At several times during past ages, these protozoans have been very abundant in shallow seas. When the animals died, their shells settled upon the sea bottom in such enormous numbers that they formed beds of limestone. Chalk is crumbly limestone made of small foraminiferal shells. Larger shells are found in the hard limestone of which buildings have been constructed for many centuries.

PROVIDENCE, R. I. The distinctive forces that shaped the character of Providence in its early days can still be seen in the names of some of its oldest streets. Its piety was shown in such street names as Hope, Peace, Faith, Friendship, Benevolent, and in the city's name. Its shrewd business sense was aptly shown in streets named Pound, Shilling, and Dollar.

Providence stands at the narrow head of Narragansett Bay, 27 miles from the open sea. To its port, coastal vessels carry cargoes of coal, lumber, and petroleum for use in Rhode Island's busy factories. The city is Rhode Island's capital and one of New England's great industrial centers. Providence stands among the leaders in manufacturing woolen textiles, cotton knit goods, jewelry and silverware, and many metal products.

Rich Historical Associations

Roger Williams, banished from Massachusetts for his religious views, founded Providence in 1636. At first the community was made up of farmers, but when shipbuilding began, in 1711, it turned to commerce, including the famous triangular trade. Sailing vessels from Providence carried rum to West Africa and traded it for slaves; brought the slaves to the West Indies and traded them for molasses and sugar; and hauled these products to Providence to be made into more rum. Some ships brought slaves to the Southern colonies. The importation of slaves was banned in 1808 by the Federal government.

Other great fortunes were made in whaling and in the trade with China. Among those who helped build Providence into a great trading city were the four Brown brothers, Moses, Nicholas, John, and Joseph. During the last half of the 1700's, they engaged in many enterprises that brought them wealth and enabled them to contribute liberally to Providence colleges and churches. Brown University, chartered in 1764, was named for Nicholas Brown in 1804.

In addition to Brown University and its affiliated women's college Pembroke, the city has Providence College and the Rhode Island College of Education. The John Hay and John Carter Brown Libraries of Brown University both have fine collec-

tions of historic documents. Roger Williams Park is part of the original tract ceded by the Indians. Providence has many old churches, including the Friends' Meeting House built in 1726 and the First Baptist Church built in 1775.

Providence was chartered in 1832. In 1900 it became the state capital, an honor previously shared with Newport. Population (1950 census), 248,674.

PRUNE. Certain varieties of plums, called prunes, have such firm flesh and such a high sugar content that they can be dried with small loss of their original plumpness and flavor. This special quality has made prunes commercially the most important of all plums (*see* Plum).

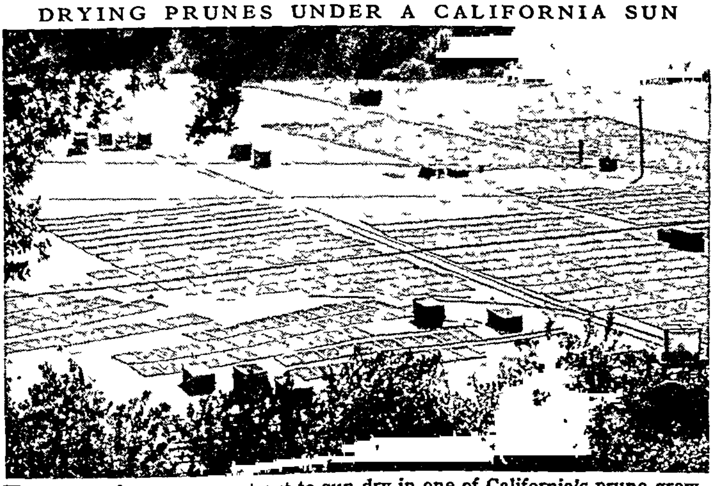
California's orchards yield the largest share of the world's prunes. Other prune-growing states are Oregon, Washington, and Idaho. The four states have produced as many as 700,000 tons of the fresh fruit in a single year. The annual value of the crop has been more than 65 million dollars. Leading producing countries in Europe are Yugoslavia and France, where dried prunes have been prepared for centuries. Argentina and Chile are South American countries which produce prunes and other dried fruits.

Prune plums are gathered from the ground after they have become so ripe that they can be shaken from the trees. The prunes selected for drying are washed in hot water or in a weak lye solution to remove "bloom" and dirt from the skins. Next, they are placed in trays and are dried either in the sun or in dehydrators (*see* Food Preservation). Sun drying takes from 10 days to two weeks; dehydration, only 20 to 36 hours. Underdried prunes ("chocolates") are removed, and the satisfactory ones are placed in bins two or three weeks or longer to soften the skins hardened by drying. Then the prunes are sacked and taken to packing plants. Here they are inspected and then graded for size on gratings, the smaller ones sifting through the holes in the gratings. Large prunes range from 20 or 30 to the pound; smaller ones run as many as 90 or 100. Next, the prunes are processed—that is, treated with hot water or steam to sterilize their skins of all contaminating material. Finally, the prunes are packed in cardboard cartons of 1 or 2 pounds or in wooden boxes containing 5, 10, or 25 pounds. The choicest are packed like dates for eating without cooking.

Prunes are a nutritious food. They are a good source of vitamins A, B_1, and B_2 (*see* Vitamins) and are rich in iron, calcium, and phosphorus. Their pulp is used as food for infants. Children and adults find prunes delicious stewed alone or with other fruit and in deserts. The pulp, the stewed fruit, and prune juice are canned commercially.

The most important varieties of prunes grown in California are the French, or Petite Prune d'Agen, the Robe de Sergeant, the Imperial, and the Sugar prune. In Oregon, the Italian prune is most widely cultivated. It is larger and more tart than the French prune and has been found highly suitable for canning without drying. Prune trees do not usually come into profitable bearing until they are six years old and not into full bearing until they are 12 to 15 years old.

DRYING PRUNES UNDER A CALIFORNIA SUN



Here trays of prunes are set out to sun dry in one of California's prune-growing valleys. Sun drying is possible because the weather is usually clear and the sun bright and hot when the fruit ripens in late summer.

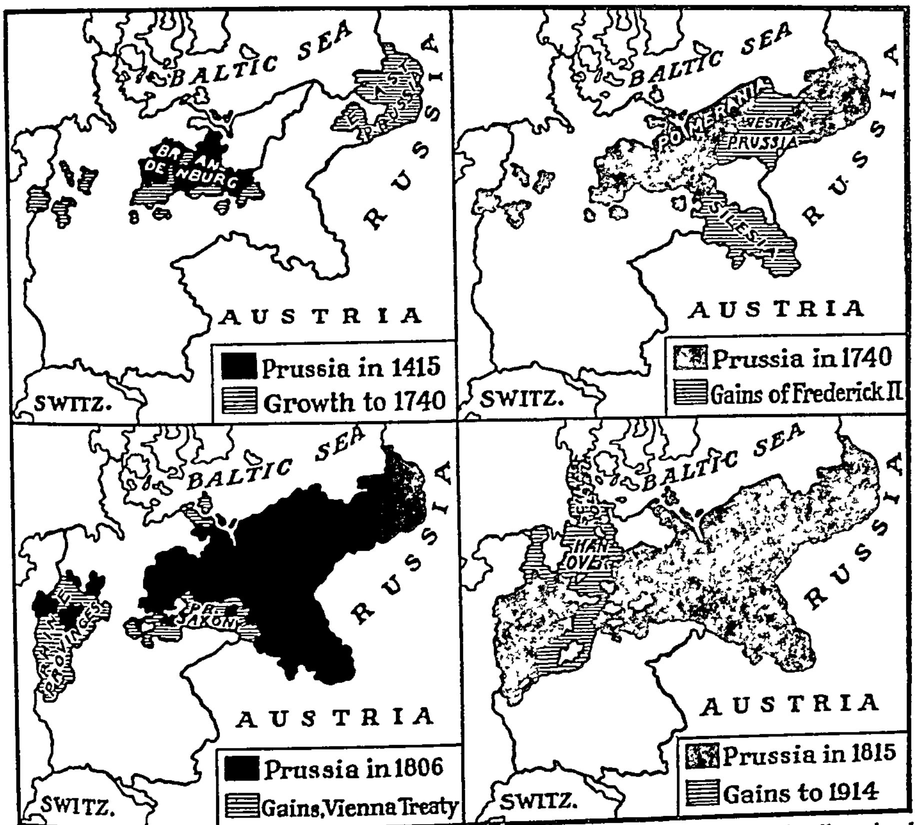
PRUSSIA, GERMANY. The ruins of the old castle of Hohenzollern, from which the former ruling family of Prussia took its name, may still be seen on a peak of the Swabian Alps in southwestern Germany near the headwaters of the Danube River. But what a contrast there is between the Hohenzollerns' tiny principality of medieval times (*see* Hohenzollern) and the mighty Prussia at the beginning of the first World War.

Three factors produced the power of the Prussian kingdom—the rise of the aggressive Hohenzollerns; their purchase of the mark, or border territory, of Brandenburg (300 miles northeast of Hohenzollern), with Berlin as its capital; and their inheritance of the duchy of Prussia, beyond the Vistula. In the 13th century, Prussia had been wrested by the Teutonic Knights from a heathen people akin to the Slavs (*Borussians*), and in 1525 it had become a secular duchy under a collateral branch of the Hohenzollerns.

The first great forward stride of the main line of the family was made in 1415, when Frederick of Hohenzollern used the wealth which he gained as "burggraf" of Nuremberg to buy from the Emperor Sigismund the rule over Brandenburg. Its possession made the Hohenzollern prince one of the "seven electors" of the Holy Roman Empire. Brandenburg, lying in the northern plain between the Elbe and the Oder rivers, was a poor flat country, with barren sand hills heaped up by the inclement winds. Gradually its Hohenzollern margraves (German *markgrafen*, "border counts") increased their territory—northward at the expense of Pomerania and Mecklenburg, southward at the cost of the Saxon marks. In 1609 the acquisition of some small isolated territories on the middle Rhine gave them a footing in western Germany.

The third important factor was added in 1618, when the duchy of Prussia fell by inheritance to the margrave of Brandenburg. It was the task of "the Great Elector," Frederick William (1640–1688), and of his successors to round out, consolidate, and strengthen these scattered possessions into a strong military state. Long wars with the Slavs and the absence of defensible frontiers had already given a military stamp to the Brandenburg-Prussian power. The Great Elector's son, Frederick I, won the title "king in (of) Prussia" in 1701. His son, the rough father of Frederick the Great, is chiefly remembered because of his fostering care of the Prussian army, and for the regiment of giants that he recruited from all over Europe—by gift, purchase, and even kidnaping.

PRUSSIA'S GROWTH THROUGH FIVE CENTURIES



The history of Prussia may be said to begin in 1415, when the Hohenzollern family gained possession of the little electorate of Brandenburg. For two centuries there was no indication that this poor flat country was destined to be the nucleus of the greatest of the German states, but after the Hohenzollerns acquired East Prussia in 1618, their dominions steadily grew until they included two-thirds of the territory and three-fourths of the population of all Germany.

What could be done by the unscrupulous use of this Prussian military power was shown by Frederick the Great (Frederick II) in his long reign from 1740 to 1786. The territory of Prussia was almost doubled by the conquest of Silesia from the young and beautiful Maria Theresa of Austria, and by the annexation —through the first partition of Poland—of West Prussia, which separated the Duchy of Prussia from Brandenburg. Incidentally Frederick helped to confirm in Prussia that belief in aggressive war as its "national industry" which lay at the root of Germany's part in the first World War.

But when Prussia measured arms with Napoleon on the field of Jena, in 1806, her armies were crushed. The reorganization carried on by Baron Stein and others enabled Prussia to take her part in the final overthrow of Napoleon in 1813–15, and as a result her territories lost to the French were restored and enlarged. A "zollverein" or customs-union helped to pave the way for political unity of the German states under Prussian headship. As a result of revolutionary movements of 1848–49 the Prussian king granted a constitution for his kingdom, in which however there were comparatively few democratic features.

Bismarck's unscrupulous diplomacy in provoking war with Denmark in 1864, with Austria in 1866, and with France in 1870, brought Prussia increased territory and the coveted German headship. Schleswig-Holstein, the kingdom of Hanover, Nassau, Hesse-Cassel, and Frankfort-on-the-Main were all absorbed into Prussia; and the Prussian king was proclaimed emperor as William I (1871–1888) of the new German Empire. Thenceforth the history of Prussia merged with that of Germany. (*See* Germany.)

It is not surprising that Prussia practically controlled the new German Empire. It included two-thirds of the area and three-fourths of the population, and its king was the German Emperor.

The treaty of peace following the first World War left Prussia still the mightiest of all German states. A republican form of government was set up in 1918. In 1933, however, the National Socialists placed Prussia under the absolute rule of a governor. Prussia absorbed the state of Waldeck in 1929, and in 1937 was given the state of Lübeck and portions of the states of Hamburg and Oldenburg. Prussian areas were given to Hamburg and Oldenburg in return. In 1939, after it had annexed Memel, its area was 114,527 square miles; its population, 41,915,000. It included the chief German industrial areas with some 35 cities of more than 100,000 population, including Berlin, Cologne, Essen, and Frankfort-on-the-Main. The second World War devastated the industries; and after Germany's surrender this artificial state—more than 500 years in the making—was abolished by the Allies in 1947.

EXPLORING *the* MIND *through* PSYCHOANALYSIS

PSYCHOANALYSIS. Psychoanalysis means literally "understanding the mind." It is both a particular technique of treating mental disorders and a special body of knowledge about human personality which has been learned through the application of the psychoanalytic method.

The psychoanalytic method was devised by Dr. Sigmund Freud of Vienna in 1881 during his attempts to treat the many symptoms of a girl suffering from severe hysteria. He found that the illness had no physical cause, but that the symptoms seemed to be connected with emotionally disturbing events she had experienced while nursing her dying father. Freud and his colleague Dr. Josef Breuer used hypnosis to induce the girl to remember and freely act out these forgotten experiences. They found that each symptom disappeared after she had done this. This type of "cathartic" or emotional acting-out treatment gave good results in other cases also, but Freud found that its effects were not permanent.

Continuing his investigations with other patients suffering from various types of mental illnesses, Freud soon discarded hypnosis in favor of the method of free association. Free association, together with dream interpretation and transference analysis, comprises the method of psychoanalytic treatment which Freud and his followers gradually developed. Today this method is used by all practitioners of psychoanalysis. (*See also* Freud.)

Free Association and Dreams

The method of free association requires that the patient attempt to say aloud every thought and feeling which occurs to him, inhibiting or censoring nothing. To help him to do this he is usually required to recline on a comfortable couch with the psychoanalyst sitting behind him, out of range of his vision. Freud and his students found that this procedure usually enabled the patient gradually to approach more and more closely an understanding of the forgotten experiences which were at the root of his illness.

Psychoanalysts also encourage their patients to report their dreams and to free-associate to the images in them. Freud believed that dreams are not accidental or meaningless, but that they contain in disguised or symbolic form an expression of important unconscious wishes and fears. Tracing out their meaning through free association may serve, therefore, to give both analyst and patient a better understanding of ideas and emotions of which the patient is consciously unaware.

The Patient's Attitude toward the Analyst

One of Freud's unique discoveries was that neurotic patients tended to develop peculiar, irrational emotional attitudes toward their analysts. Despite the fact that the analyst purposely remained neutral, neither sympathizing with nor condemning anything the patient said, Freud found that patients almost invariably experienced strongly affectionate or hostile feelings toward him. These feelings constituted a resistance to treatment, since they prevented the patient from continuing to associate freely.

In studying this phenomenon Freud came to the conclusion that these emotions had little to do with the analyst as a real person. Instead, the analytic situation had caused the patient to experience again his forgotten childish dependence on his parents and to *transfer* this emotion to the analyst. According to this theory the transference may become a real aid in treatment, since the analyst can observe it carefully. Thus he can discover the nature of the unreasonable and immature attitudes which have persisted from the forgotten past and which unconsciously may still seriously disturb the patient's present relationships to people.

Acceptance and Value of Psychoanalysis

Freud's psychoanalytic method at first met with scorn from the medical profession, but it has received increasing support. Physicians trained in its use have reported that it can accomplish more with certain types of patients than any other method of treatment. Freud himself treated principally hysteria, anxiety states, and phobias, but his method has also been used extensively with apparently good results in almost every type of psychoneurosis and character disorder. Until recently it was not believed that psychotic (insane) patients could be treated by psychoanalysis, but research studies in several mental hospitals have reported improvement or even cure of some cases of the very severe psychosis called *schizophrenia*.

How effective psychoanalysis is and for what kinds of patients it is most suitable remain debated issues. Scientific evidence has been difficult to obtain because it has so far not proved possible to institute controlled experiments to test the relative efficiency of psychoanalysis.

One of the greatest difficulties of psychoanalytic treatment is the very heavy demands it makes upon both analyst and patient. The analyst must have long special training, including a personal analysis, during which not only does he learn the technique at first hand but he also becomes aware of any irrational unconscious attitudes of his own which might otherwise interfere with his understanding of his patients. Furthermore, the exploration of each patient's mental processes is a very lengthy procedure. The patient not only must be prepared to suffer anxiety but also to make sacrifices of time and money. The effectiveness of psychoanalysis as a treatment for mental disorders depends upon many factors: the training and skill of the analyst; the age, intelligence, and motivation of the patient; and the type of disorder from which the patient suffers.

Studying the Mind through Psychoanalysis

Many psychoanalysts believe that psychoanalysis is even more important for the information it gives about the workings of the human mind than it is as a method of treatment. Most psychologists have con-

centrated their attention upon man's observable behavior and his conscious mental processes, such as sensation, perception, learning, and emotion. Psychoanalysts have attempted to develop a science of the unconscious. This is usually called *depth psychology*, or *dynamic psychology*. This theory, which is based upon observations of neurotic people through the use of psychoanalytic methods, holds that mental illness (as well as many minor normal mental aberrations) results primarily from repression of disturbing emotional experiences in childhood.

Repression means the automatic forgetting of an experience which is so disturbing that the child cannot endure the pain of thinking about it. Psychoanalysts believe that repression occurs to some extent in everyone—that it is a normal human mechanism for avoiding too intense psychological distress. It is considered to be analogous to fainting or "blacking out" when physical pain becomes too great. The theory of unconscious motivation further holds that repressed experiences are not permanently forgotten. Instead, their effects continue a kind of underground existence. As events occur in the person's life which are in any way similar, or related even very indirectly, to the repressed experiences, some form of disturbance occurs. This disturbance, or symptom, is related to the repressed experience and can only be understood and controlled, or eliminated, when the repression has been overcome and the unconscious mental act is replaced by conscious understanding.

Repressions in Early Childhood

Psychoanalysis stresses the importance of early childhood, for it is believed that most repressions occur during the first few years of life. The immature mind of the child cannot understand the true nature of many events he experiences, and repression protects him from the pain of continuing to remember very frightening or otherwise very unpleasant events. The helplessness of the child and his dependence for many years on his parents or other adults mean that the way they treat him and his attitudes toward them are the most important factors in determining how much repression will occur and what will be repressed.

Psychoanalytic investigators have held that mental illness results primarily from real misfortunes in early childhood or from the child's mistaken impressions of his parents' feelings toward him. Many neurotic people have apparently repressed the impression that their parents did not really love them, that they were really adopted children, or that the love of a boy for his mother might be punished by his father as if the boy were a grown-up rival. This last idea Freud called the *Oedipus complex*. The ancient Greek tragedy of Oedipus tells of a king who was separated from his parents at birth and who, upon encountering them again as a grown man, unknowingly murdered his father and married his own mother (*see* Oedipus).

Freud also stressed the importance of incorrect information and inflexible attitudes about sex. These factors frequently required the child to repress experiences which frightened him but which he dared not discuss with anyone. Furthermore, Freud suggested that human sexuality did not have its beginning at puberty but was an inherited biological drive which had a long history in the individual. How well the person could adjust to sexual maturity, Freud believed, depended largely on the character of his earlier experiences with affection, the correctness of his information, and the manner in which his parents or other adults had responded to his childish quest for sexual information and experience.

Some confusion has arisen with respect to Freud's theory of the importance of childhood sexuality because he used the term sex to apply to a wide range of behaviors and attitudes, including everything related to what is ordinarily called affection and love. Although sexual repression undoubtedly plays an important role in many neuroses, psychoanalysts today tend to stress more the entire relationship of the child to his parents—how secure he feels with them, how fairly he believes they treat him in comparison with brothers or sisters, and how sure he is of their love for him and their acceptance of him.

Other Schools of Psychoanalysis

As more and more psychiatrists and psychologists were trained in psychoanalytic methods, various divergences from Freud's views arose, and some of his students started schools of their own. Alfred Adler developed *individual psychology*, which stressed the importance of the inferiority complex and the drive to succeed as factors in the formation of neurosis. Carl Jung evolved a system of thought that he called *analytical psychology*, which borrows heavily from Hindu mysticism and which stresses the *collective unconscious* (the persistence in the mind of ideas inherited from man's remote ancestors). Jung's theories are not in agreement with contemporary biology and so have had little influence on the general development of psychology and psychiatry. Both Adler and Freud have influenced the thinking of many psychologists who are not themselves psychoanalysts.

In the United States since the 1930's Karen Horney, Erich Fromm, and Harry Stack Sullivan have been influential. They have especially stressed the importance of the culture, or general environment, in determining the kinds of problems people have and the inadequate ways they unconsciously adopt to deal with them. Their followers are usually referred to as neo-Freudians, or the Cultural School of Psychoanalysis, to differentiate them from those who emphasize Freud's more biological point of view.

Although there are differences in emphasis among the various present-day schools of psychoanalysis, all of them base their theories upon Freud's work and all accept his concept of unconscious motivation. They vary among themselves in the relative importance they place upon biological and cultural factors, in the extent to which they rely upon free association, and in the use they make of dream interpretation. (*See also* Psychology, especially the Reference-Outline at the end of the article.)

PSYCHOLOGY—*The* SCIENCE *of* BEHAVIOR

PSYCHOLOGY. A broad definition of modern psychology is the *science of behavior*. Psychology is concerned with what adults, children, and animals *do*. Psychologists investigate such problems as development of intelligence, individual differences in intelligence and personality, learning, forgetting, acquisition of language, group behavior, and the diagnosis and treatment of behavior disorders.

Typical of the questions they ask are: Why doesn't Mary eat? Why is she afraid of Aunt Jane? Can her fear be overcome? What are John's chances of success in medical school? Why can't Charles concentrate? Why is Bill so shy? Is there anything he can do to improve his personality? Can mental illness be prevented?

These two three-year-olds are placing blocks in the proper holes in a form board. The chimpanzee is doing about as well as the little boy. As they grow older the superior intelligence of the boy will become increasingly apparent.

Psychology has much in common with biology, the science of living things. Psychologists have a special interest in the brain and the rest of the nervous system, as well as in the glands and other organs. Their interest, however, stems only from the fact that these help to explain behavior.

Psychology has much in common with social science also. Man is greatly influenced by what other people say and do. His moral and religious behavior is influenced by what people said who lived thousands of years ago. Intelligence and personality are to some degree molded by parents and teachers. For these and other reasons, psychology is a social as well as a biological science.

Historical Development of Psychology

Psychology has not always dealt with behavior and with practical problems of everyday life. Like most other sciences, it was once a branch of philosophy. The word comes from a combination of two Greek words, *psyche* ("mind") and *logos* ("discourse"). To Greek philosophers, psychology was the study of the mind, or mental philosophy. Mental philosophers discussed such issues as: What is mind? How are mind and body related? How accurately do our senses reveal the nature of the world around us? Such questions aroused much speculation, but seldom did two authorities give the same answers.

Wilhelm Wundt (1832–1920) believed that psychology could become a science if it gave up mere speculation and engaged in experimental research. At the University of Leipzig, in 1879, he opened the world's first laboratory for the experimental investigation of psychological problems. Wundt and his students focused their attention upon consciousness; that is, upon our awareness of ourselves and the world about us. The chief experimental method came to be known as *experimental introspection*. Introspection is a kind of "looking inward." The experimenter made various changes in light, sound, and other stimuli, and the subject described his experiences.

It appeared to these investigators that consciousness could be broken down into small "bits of experience" called sensations, images, and feelings (*see* Sensation and Perception). Such were the "elements" of mind. Those who studied consciousness in this way were called *structuralists*, because they tried to describe the contents, or structure, of mind.

The scope of psychology began to broaden when certain investigators became interested in studying the *functions* of consciousness instead of the structure of mind. The *functionalists*, as they were called, believed especially that consciousness aids in the learning process. They undertook experiments on learning in animals and in human children and adults. Their psychology became very broad, dealing with intelligence, personality, and many practical problems of education. Functional psychology developed at the University of Chicago under the leadership of John Dewey (1859–1952) and James Rowland Angell (1869–1949) and at Harvard University under William James (1842–1910).

Gestalt Psychology

A group of German psychologists led by Max Wertheimer (1880–1943) and Wolfgang Kohler (born 1887) also criticized the structural movement. These men called themselves *Gestalt* psychologists. The word "Gestalt" means configuration, whole, or pattern. By analyzing experiences into "bits" such as sensations, the structuralists had implied that our awareness of the world about us is a mosaic. The Gestalt psychologists said that experience is not like this at all.

MEASURING THE REACTIONS TO AN EMOTION

The machine, called a polygraph, registers the physical reactions to an emotion—fright caused by the explosion of a pistol. The various instruments record such things as pulse, blood pressure, skin temperature, breathing, and tremors in the fingers.

Just as we are not aware of the oxygen and hydrogen of which water is composed, we are not, they claimed, aware of sensations. Rather we are aware of people, cars, and other meaningful things.

Wertheimer drew attention, for example, to the perception of movement in motion pictures. Actually there is only a succession of still pictures on the screen, yet our experience is of moving people and objects. We are not aware of the separate pictures.

Although much of the work of Gestalt psychologists dealt with perception, they were also interested in learning. Here again they were critical of earlier concepts. Edward L. Thorndike (1874–1949) of Columbia University, as well as the functionalists at Chicago, had come to the conclusion that learning is a sort of trial-and-error, hit-or-miss affair, in which errors are gradually eliminated. Their experiments had called upon animals to solve mazes and puzzle boxes. The animal usually made many different responses, some correct and some incorrect. In successive trials, if appropriate rewards were offered, the animal would gradually drop the incorrect responses and retain the correct ones. Eventually it would run through the maze without errors or open the puzzle box without false moves.

Insight in Animals

Köhler, in his now classic experiments on the mentality of apes, found evidence that animals are capable of a higher type of learning, which he called "insight." In one experiment a hungry chimpanzee was confronted with a banana well out of reach above the cage. In the cage were placed several boxes. Instead of trying this or that response and gradually eliminating errors, a chimpanzee would sometimes look the situation over, then suddenly stack the boxes one on top of the other and clamber on top to seize the banana. (For pictures of this experiment, *see* Learning.) Later experiments showed that animals as lowly as the rat are also capable of sudden learning. Insight is most evident, however, in man himself.

Science of Behavior

As psychology developed there was increasing emphasis upon behavior. Many investigators were dissatisfied with introspective approaches. They pointed out that conscious experience is subjective; that is, it is known only to the person who has it.

What an individual does is objective because it may be observed, photographed, and in other ways pinned down for careful examination. Actions, including what is said and written, are forms of behavior. They may be studied by methods of observation like those used in the physical and biological sciences. Recognition of this fact gave rise to the movement known as behaviorism.

The leader of the behaviorists was John B. Watson (born 1878), professor of psychology at Johns Hopkins University. Watson's early research dealt with learning in animals. In this work the introspective method, of course, could not be used. Later, in studies on the development of behavior in infants, Watson could be concerned only with actions.

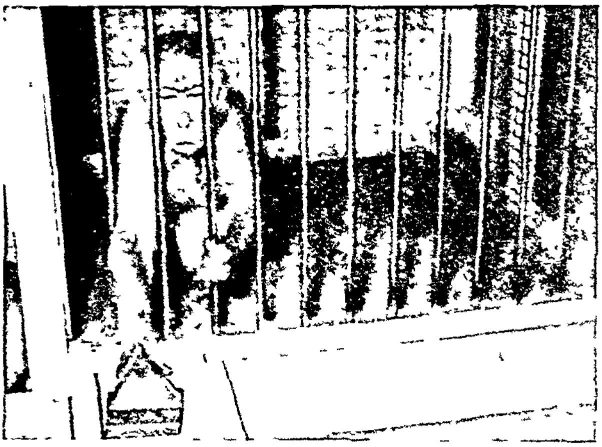
He came to the conclusion that even the behavior of human adults should be studied without reference to conscious experience. This idea aroused considerable controversy, but it has now largely died down. Only a few psychologists still use introspective methods and are interested in describing conscious experience. The major emphasis in all fields of psychology today is along objective, behaviorist lines.

Freud and Psychoanalysis

Many people suffer from physical, nervous, and emotional disorders for which there is no organic explanation. A Viennese physician, Dr. Sigmund Freud (1856–1939), developed a new theory, that of *psychoanalysis*, to explain the psychoneuroses.

Freud became interested in what he called the subconscious and its effect on the conscious mind. The subconscious, he believed, is the repository of desires and experiences of which we are no longer aware. He emphasized sexual desires as strong forces and claimed that dreams express submerged desires in symbolic form. The conflicts resulting from the de-

A RECOGNITION TEST—MATCHING FROM SAMPLE



The monkey is trained to lift an object to obtain food. Then it is trained to lift an object resembling whatever sample is shown him. A triangle is shown, then removed. Several minutes later the triangle and several other forms are shown. The monkey must lift only the triangle. Then a circle alone is shown. This time it must select the circle from among the other forms.

mands of living and the repressed desires and experiences stored in the subconscious were the cause of mental disorders.

Many psychologists object to psychoanalysis because it is entirely subjective. Nevertheless, it has profoundly influenced modern thinking. (*See* Freud; Psychoanalysis.)

Fields of Psychology

Like other sciences, psychology is divided into a number of special fields. We can better understand the broad scope of modern psychology by examining some of these various fields.

Experimental psychology is the parent field. Only with the study of human beings under controlled conditions in the laboratory was the modern science divorced from the armchair speculations that preceded it. Students in university and college laboratories are required to repeat important experiments so that they will become familiar with research techniques. Such experiments usually involve measuring speed of reaction, learning new skills, memorizing various kinds of material, and recording reactions to emotion-arousing stimuli. The subjects are usually animals and other students. *Physiological psychology* studies the relations between behavior and the sense organs, nervous system, muscles, and glands.

Animal Psychology

Animal psychology focuses on the behavior of animals and the use of animals as tools to investigate psychological processes. Animals and men have essentially the same physiological-drive mechanisms. However, human beings are guided by customs, laws, habits, and ideals. To get below the surface of culture and discover something of man's purely animal nature, psychologists must use animals.

Psychoanalysts have suggested that man's strongest motive is sex. However, animal studies have shown that hunger and thirst are stronger. The strength of each drive is measured by seeing how many times, in a standard interval, the animal will cross an electrified grid to reach food, water, or a member of the opposite sex. Comparisons are based upon the average performance of large groups.

The term *genetic*, or *developmental, psychology* designates all psychological research on development whether it deals with animals or humans or with childhood, adolescence, or old age.

Child Psychology

Child psychology covers development from infancy to adolescence. It studies the growth of walking, speech, play, emotion, intelligence, personality, and social interaction (*see* Child Development). Children have many behavior problems and it is important to find how best to deal with them. Child psychology makes valuable contributions to mental hygiene (*see* Mental Hygiene). This is concerned with the early detection and correction of behavior problems which may lead to mental illness in later life.

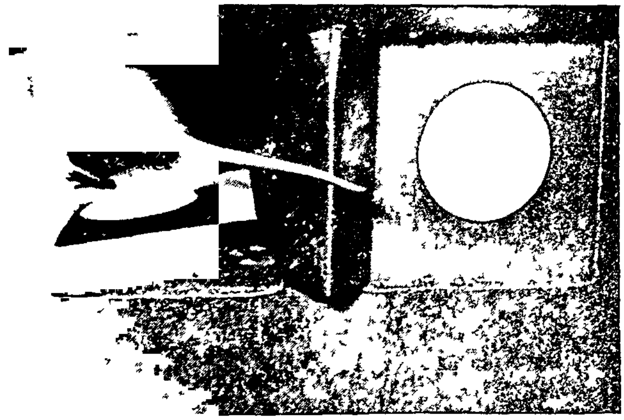
The *psychology of adolescence* deals with development during the years from puberty to adulthood. The problems evident in this age group usually fall within the fields of sexual, social, and vocational adjustment. Psychologists are also interested in later maturity and old age. There are now more elderly people in the total population than ever before. Their problems of adjustment to a less active life are frequently as pressing as those of adolescents.

Abnormal psychology concentrates upon behavior disorders. It overlaps a branch of medicine known as psychiatry. Study in this branch includes such topics as abnormalities of perception, emotion, and memory; neurotic behavior, such as hysteria and compulsions; and psychoses (insanities), such as schizophrenia and manic-depressive disorders.

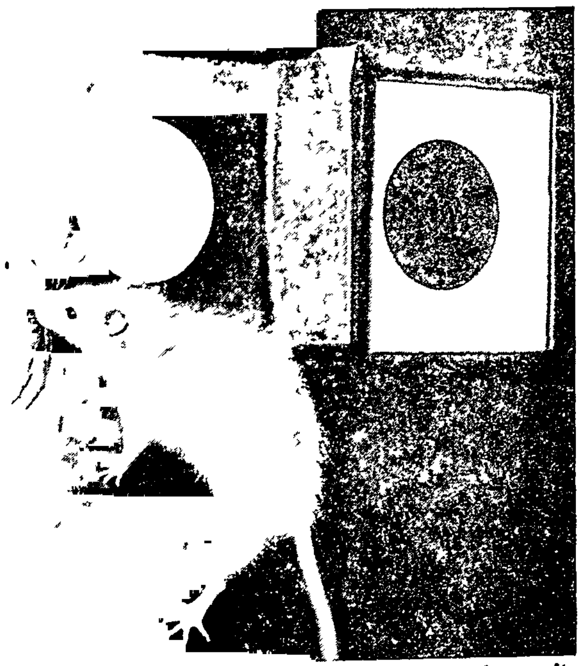
Since the first World War, attention has been given to mental illness among those involved in combat. The term "combat fatigue" has come into use as a means of classifying these disorders.

Abnormal psychology is also of great value to ministers, lawyers, and social workers who are called upon to help the depressed, the emotionally insecure, the criminal, or other antisocial persons.

LEARNING A DISCRIMINATION PROBLEM



When the rat jumps against the correct card it proceeds to a food platform beyond. In this picture a correct response is shown. The card falls, and the rat obtains food.



The position of the cards has been changed. The rat bumps its nose and falls into a net. It must learn after repeated trials that the card with the black circle produces food.

Social psychology examines individual attitudes and personality developed by living in groups, such as the family, neighborhood, and nation (*see* Sociology). The field also includes the psychology of crowds, audiences, nations, and races. It examines psychological warfare and propaganda as means of influencing groups. The measurement of opinions and attitudes by public opinion polls falls within this field. *Racial psychology* deals with racial differences and the problems resulting from cultural minorities.

Applications of Psychology

The term *applied psychology* covers application of psychological methods and findings to the problems of everyday living. There are five branches: educational, clinical, vocational, industrial, and business.

Educational psychology applies the findings of child psychologists to the problems of understanding school children. Studies of individual differences are required (*see* Individual Differences). Alfred Binet (1857–1911) developed intelligence tests so that teachers could have something more reliable than their own judgments in deciding whether a child had sufficient intelligence to profit from a certain level of training. Tests of this type are now widely used to decide whether a child is mentally retarded and whether he should be placed with, ahead of, or behind his age group (*see* Intelligence Tests; Mental Deficiency). Measuring techniques called *achievement tests* are applied to specific fields of schoolwork and can be related to the learning rates and learning difficulties of children at all levels.

Tests of personality and of music, art, and special aptitudes are also used in schools. Within the classroom itself there are opportunities to apply what psychologists have discovered about learning, remembering, and study (*see* Learning; Memory; Study).

In the field of *clinical psychology* psychiatrists and clinical psychologists apply what they have learned in their study of abnormal psychology. The psychiatrist is always a doctor of medicine and can thus use medical as well as psychological procedures. Although some clinical psychologists are doctors of medicine, most of them have a degree of doctor of philosophy. This does not give them the right to practice medicine.

Psychiatrists are especially concerned with the more serious mental illnesses which often require hospital treatment. Except where they work with psychiatrists in mental hospitals, clinical psychologists are more likely to be interested in the behavior disorders which arise in the home and in the school. Some of them practice as private consultants, and many work in homes for the feeble-minded, in psychiatric clinics, in schools, and in colleges. Many are employed by the Veterans' Administration.

The tests which psychologists have devised to measure intelligence and personality often show why a behavior problem exists. The child who is "bad" in school or at home may be so because he is expected to do more or less than his ability level. Or he may have a correctible personality defect.

Diagnosing Mental Illness

The Rorschach test is widely used to suggest what may be wrong with a patient. The test is a series of ink blots to which people with "queer" ideas usually have "queer" interpretations. These reactions fall into patterns which are diagnostic. Such patterns reveal the type and sometimes the source of the patient's problems.

Pictures are used similarly in the "thematic apperception test." The patient is asked to make up a story about each picture. The stories may have a common theme, as of melancholy or fear. Like the ink blots, they disclose a great deal about personality (*see* Personality).

Another method used to help people solve their problems is psychoanalysis. The patient usually reclines on a couch and talks about anything which comes to mind. This is known as "free association of

ideas." Free association continues, often in a long series of sessions, until the analyst is able to reconstruct the patient's past—his childhood experiences, his relations with his parents, his conflicts. Dreams are studied for what they may reveal about desires.

A newer, briefer, and less expensive method is known as "client-centered therapy." It was developed by Carl R. Rogers (born 1902) and is now widely used by clinical psychologists. The client is encouraged to talk about his problems. The psychologist listens sympathetically and guides the talk into channels which will enable the patient to see for himself what is wrong and what should be done. The aim is thus to help the patient achieve insight for himself.

Much harm may be done if a patient follows the advice of a quack. The qualifications of a person calling himself a psychologist may be obtained by writing to the American Psychological Association, 1333 Sixteenth Street, N.W., Washington, D. C.

Psychology in Industry and Business

Vocational psychology helps an individual to decide what sort of lifework he should choose. Vocational counselors are employed by high schools, colleges, and government agencies. Through tests and interviews the counselor attempts to discover aptitudes for particular studies or occupations (*see* Vocations). The Medical Aptitude Test which all applicants for medical school must take and the Seashore test for musical talent are examples of many which indicate the likelihood that a person will succeed or fail in a vocation.

Industrial psychology is in part concerned with the same problems as vocational psychology. However, the industrialist has jobs to be filled, and he wants to find people who can fill them efficiently, who will be happy in their work, and who will remain on the job after they have been trained. The industrial psychologist is often responsible for training workers, for establishing procedures to reduce accidents, and for promoting good relations between employees and their employers.

Psychologists in industry and in the government are also doing research on what is sometimes called "human engineering." This is the task of designing machines so that men can operate them efficiently. Research in this area was so important during the second World War that Walter S. Hunter (born 1889), chairman of the Applied Psychology Panel of the National Defense Research Council, was given the President's Medal of Merit. The citation referred to "research on the psychological and physiological capacities of man in relation to the new instruments of warfare" which "contributed materially to the more effective utilization of both military personnel and instruments."

Business psychology covers the work of vocational and industrial psychology. In addition it deals with problems of marketing, such as discovering the potential market for a new product; how to package it attractively; and the most effective promotional methods. This is known as market research. Advertising research is another aspect of business psychology (*see* Advertising).

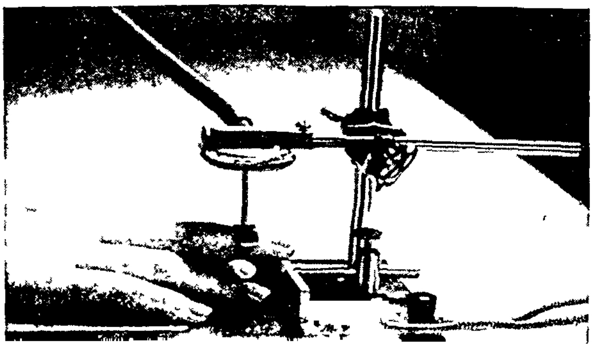
Current Trends in Psychology

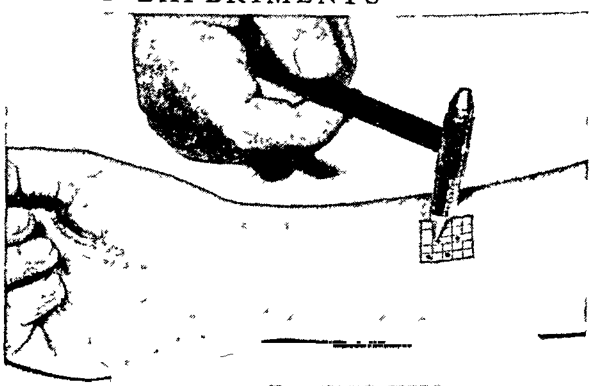
Most psychological research is now focused upon aspects of behavior. The aspect most widely investigated in the laboratory is the learning process. This is because learning forms the basis of almost everything which enables us to make a living and live together.

Clinical psychology as an applied field is also developing rapidly. The need for psychologists in this field is far greater than the supply. Current research is concerned with improving the accuracy of tests and with weighing the relative values of different forms of treatment for specific behavior and learning problems. Government agencies such as the Veterans' Administration and several private foundations are trying to help in the training of large numbers of clinical psychologists. Many are now working in teams with psychiatrists and psychiatric social workers, a trend which seems likely to continue.

Another field of great current activity is the so-called "human engineering" which, as we have seen, involves adapting machines to men and the efficient training of men to operate them.

SOME COMMON LABORATORY EXPERIMENTS





This apparatus (left) is used to study the conditioned reflex. An electric shock causes the finger to lift. If a bell is rung before the shock, eventually the finger lifts when the bell rings and before a shock is received. The pointed metal cylinder (right) locates areas of skin sensitivity—hot, cold, pain, pressure—on a sample square of skin on the forearm.

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PTOLEMY (*tŏl'ĕ-mĭ*). Among the most trusted generals who accompanied Alexander the Great on his conquests in Asia was a Macedonian named Ptolemy, who became one of the seven bodyguards attached to that king's person. After Alexander's death (323 B.C.), Ptolemy received Egypt in the division of the spoils of empire, and ruled it for 38 years. He was the founder of a line of Greek rulers in that country, of whom the last was Ptolemy XIV, or Caesarion (47–30 B.C.). He was the son of Julius Caesar and Cleopatra, and became joint ruler with her. Both met violent deaths in 30 B.C. Egypt then became a Roman province, and the Ptolemaic rule ended.

About 170 years later, new distinction was conferred upon the name Ptolemy by the famous astronomer, geographer, and mathematician, Claudius Ptolemaeus. Whether he was related to the royal house of Egypt is uncertain. All we know of him is that he was a native of Egypt and lived in Alexandria, and probably died soon after 161 A.D.

Ptolemy was a compiler rather than an original thinker or investigator, but he did his work so well that his books remained the standard textbooks down to the close of the Middle Ages.

In astronomy his great work was the 'Almagest', as Arab scholars called it, from the Arabic words meaning "the greatest." This contained the first treatise on trigonometry, which Ptolemy developed for the use of astronomers. Ptolemy explained all the motions of the heavenly bodies on the theory that they all revolve around the earth; and this theory held sway until Copernicus showed its error.

Ptolemy's 'Guide to Geography' was chiefly a set of maps and a list of places with calculations of their latitude and longitude. These calculations were based on an underestimate of the size of the earth and so contained serious errors, but his maps were not improved on for more than 12 centuries.

PUBLIC UTILITIES. When we want gas, electric light, or telephone service, usually we cannot choose among different companies, as we can in buying most other things. There will be just one company of each kind in our community. That company is obliged to serve us, provided we observe its rules and pay its charges; and its services and charges are regulated by the government. Such a company is a *public utility*, or *public service industry.*

Social Control Necessary

Pub[illegible]lities differ from other business enterprise[illegible] *a special public interest. The services* they [illegible]re more or less indispensable to the comm[illegible]ey usually need special grants of privileg[illegible]te, such as the right to use the public st[illegible]v gas mains. They usually have a monopol[illegible]e approach to monopoly of their functions. [illegible]se *and other reasons they are* regulated b[illegible]vernment.

Until the t[illegible]r the Civil War, the only common public utilities [illegible]e ferries, bridges, canals, and toll roads. To induce men to build them the government let the builders charge tolls, and gave them a monopoly of the business. On the other hand, the government insisted on the right to regulate them to insure good service and fair rates.

When inventors gave us gas, electric light and power, the telephone, and street cars, it seemed at first that competition between different companies would insure good service and low rates. But it was soon found that there could be little competition in public utility businesses. One reason is the expensive equipment each company needs. Two telephone companies, for example, might have to spend a million dollars apiece for equipment in a city, whereas one company could serve the city with equipment costing only 1½ millions. Besides, *it is inconvenient for the* public to have two telephone systems in the same community. So most public utilities naturally tend to become *monopolies*, because the public is better and more economically served when there is only one large company for each kind of service.

Local utilities, such as water, light, telephone, and street-car companies, were at first regulated by the communities through charters or grants of *franchises.* Services affecting a larger area, such as railroads, were regulated by state legislatures through provisions in their charters.

As these businesses grew in importance and power, this machinery of regulation proved inadequate; and early in the 20th century all the states except Delaware set up state public service commissions to deal with utilities. Utilities operating outside the limits of a single state are regulated by such federal agencies as the Interstate Commerce Commission, the Federal Maritime Board, the Maritime Administration, the Federal Power Commission, the Federal Communications Commission, and the Civil Aeronautics Board.

The state commissions usually have control over rates, service, and accounting. Some also have authority over new issues of securities. The commission can order changes in rates or service if it believes them to be warranted. If the public service company believes that the commission's order will prevent it from earning a fair return on its capital, it can appeal to the federal courts *to set the order aside.*

Public and Private Ownership

Public ownership of utilities has increased in the United States since the first World War. Most cities own their water services, and many operate gas, electric power, and street-car services. The federal government *has set up vast projects that combine hydro*electric development with flood control, irrigation, or water supply (*see* Dam; Irrigation; Tennessee Valley Authority). The oldest and best-known federally operated utility is the Post Office.

Opinion is divided on public ownership of utilities. *Those who favor it say that the demand of private* concerns for profit leads to high rates and poor service. Those opposed argue that government operation is seldom as efficient as private management, and that it is subject to political abuse.

In Canada and the European countries public ownership is more common, and railroads, telephone and telegraph services, and other public utilities are government operated to a considerable extent.

PUEBLO (*pwĕb'lō*) **INDIANS.** In New Mexico and Arizona live the Pueblo Indians—the Hopi, Zuñi, Taos, Isleta, Jemez, and others. They follow the way of life developed by their ancestors to fit this land of scanty rainfall. They live in compact adobe villages, first called "pueblos" by Spanish explorers. They grow their food in distant fields, watered by irrigation systems they have built. There are 28 pueblos which are still inhabited, in addition to hundreds of ruined structures which formerly were populous centers. Among the most interesting are the now deserted homes of the Cliff Dwellers, who were ancestors of the present tribes. (*See also* Indians, section "Southwest Farmers and Herders"; Cliff Dwellers.)

The typical pueblo was often built, for defensive purposes, on the top of a lofty flat-topped hill, called a *mesa.* It is a many-roomed structure of two to seven stories piled one upon another, like a series of terraces, so that the roof of one building is the "front yard" of the next above. The upper houses are reached by means of ladders. Slabs of sandstone laid in adobe mortar are used as building material, but most of the modern villages are built of sun-dried bricks.

The present-day Pueblo Indians are industrious farmers and skillful potters. Some are basketmakers and weavers, like their ancestors. Except for nine Hopi villages in Arizona, they all live in New Mexico. They are nominally Christian, though they still retain many of the rites and customs of their ancient faiths. Their ceremonial dances attract many tourists each year. Number of Pueblo Indians, about 19,000.

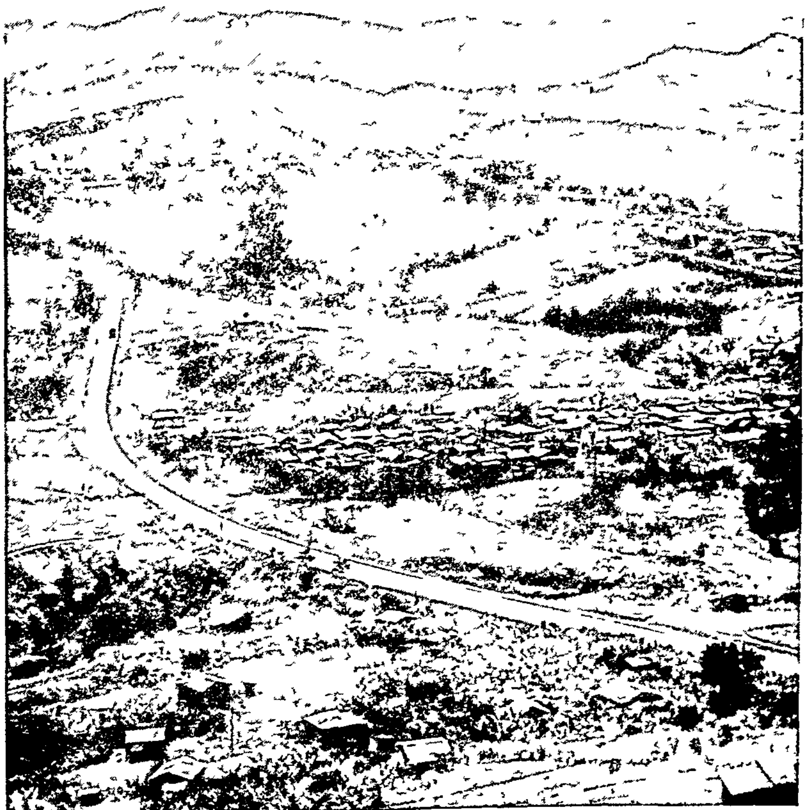
ISLAND *Life* *in* CROWDED PUERTO RICO

PUERTO RICO. The only part of United States territory where Christopher Columbus set foot is the West Indies island of Puerto Rico He landed on its west coast in 1493, on his second voyage, and claimed the land for Spain. After four centuries of rule, Spain ceded this land to the United States on Dec. 10, 1898, following the Spanish-American War.

The name Puerto Rico means "rich port," but the beautiful tropical island is a problem spot. Its population of 2,210,703 (1950 census) is too great to be supported by farming the 3,435 square miles of mountain and lowland. Today its leaders are striving to develop the island's resources and to attract industries that will create employment and income.

Location, Size, and Nature of the Land

Puerto Rico lies about 1,000 miles southeast of Miami and 1,400 miles from New York. It belongs to a chain of volcanic islands encircling the Caribbean Sea (*see* West Indies). Roughly rectangular, it measures 100 miles from east to west and 35 miles from north to south. Mountain ranges cross the island, parallel with the southern coast and from 10 to 15 miles inland. The Cordillera Central rises to the west and the Sierra de Luquillo to the east. Cerro de Punta, 4,389 feet, is the highest point.



Here the town of Cayey lies on moist northern mountain slopes beside El Camino Real, the old military road. Cane fields cover the land from the village to the hilltop.

Limestone spurs and hills branch fanwise from the main ranges. Around the core of mountains and hills spread the coastal plains. The rivers that plunge down the slopes have cut deep gorges and brought alluvial soil to enrich the plains.

Tropical Trade-Wind Climate and Vegetation

The island lies within the tropics and enjoys warm weather the year around. The average daily maximum

is 86°F. and the average minimum about 67°. Refreshing trade winds blow from the east and northeast, and at night land breezes sweep from the mountain heights.

The mountain barrier wrings moisture from the trade winds, bringing heavy rainfall on the northern slope and plain. The south is so dry it must be irrigated for farming. At times the island has been parched with drought. Again it is swept by hurricane.

A MAYAGÜEZ HANDKERCHIEF FACTORY

These factory girls are packing finished handkerchiefs for export to the United States. Embroidery and other handwork on Puerto Rican linens is done by country women in their homes.

Once the well-watered areas were clothed in a thick rain forest of tropical trees, vines, and plants. But the land was cleared for farming and timber was cut for lumber and charcoal. Today the only large forests left are in the preserves. The government forestry service has planted millions of hardwood lumber trees and more millions of quick-growth trees to check erosion and to supply the charcoal burners. In the drier sections, some areas support only shrubs, or even cacti and thorny acacias. The island has few mineral resources.

Farming People in a Crowded Land

Most of the Puerto Ricans are white people of Spanish descent. About a fourth are Negroes and mulattoes, descended from slaves brought to the islands from the 16th to the 18th centuries. Only a few are descended from the original Indian inhabitants. These were peaceful, farming folk of Arawak stock, called Boriqueños, from their name for the island. They did not survive the Spanish attempt to enslave them and disappeared by 1582.

Spanish is the native language. Perhaps a third of the people can speak English, which has been taught in the schools since 1900. Puerto Ricans are predominantly Roman Catholic.

About three quarters of the people make a living on the land, though there is an average of less than two thirds of an acre of tillable ground to the person. There are about 644 people to the square mile. This is almost 13 times as great as the United States average of 50.7 to the mile. In New Jersey, where the density is about the same as that of Puerto Rico, industry and trade support the people.

WORKERS ON THE LAND

The boys at the left are setting out tobacco seedlings on a hillside. Cultivation of the steep slopes has led to serious erosion. At the right a jibaro farm worker swings his sharp machete to chop a stalk of sugar cane. The harvest lasts from mid-January to June.

How the People Live

The country people are called *jibaros*. About 50,000 of them own their small farms. But most jibaros work for the big sugar plantations. Sugar cane grows across the coastal plain and well up the hillsides. Most of the land belongs to a few large plantation operators, including the sugar *centrals*, or factories. Few planters have farm machinery. The jibaros plow the land with ox teams, set out the cane shoots, and hoe the weeds. At harvest time an army of workers cut the cane with huge knives, called machetes. They haul the crop to the central in ox-drawn wagons, in trucks, or in railroad cars. After the last load goes, many workers face six months without work.

The planters cannot spare good cane land for gardens or pasture. So the jibaro families buy rice, beans or peas, salt codfish or pigs feet, and coffee for their meals. Most of this food is imported.

In the hilly country tobacco is a leading crop. The farmers plant it in November and harvest it in March. Then they clear the ground and sow corn, beans, or a starchy, tropical root vegetable, such as sweet potatoes, yams, cassava, tania, or dasheen.

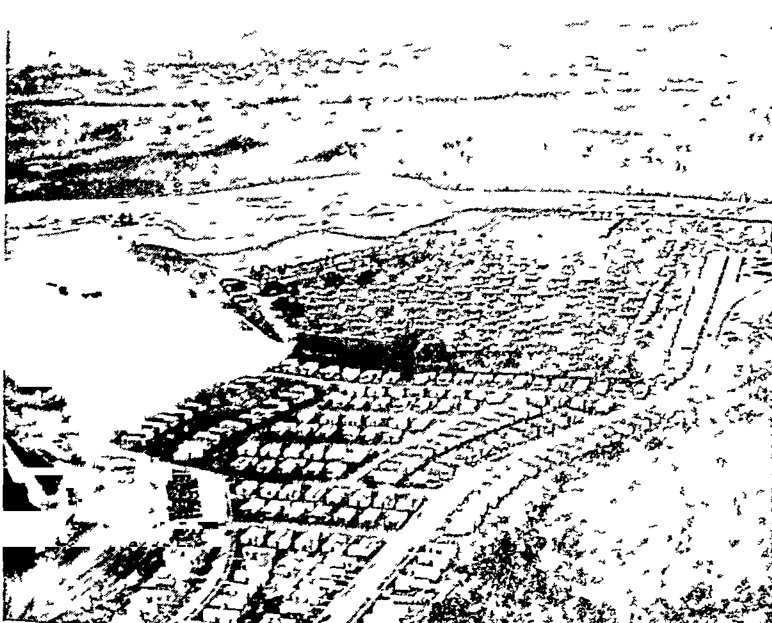
The coffee planters high on the steep mountains can usually spare land for a garden or to pasture a goat for milk. They get fruit from orange trees, mangoes, plantains, or bananas set to shade the coffee bushes.

Problems of Housing and Land

The jibaro's house is no more than a cabin of rough boards. Thousands of families are landless squatters, called *agregados*. They may beg space for a hut on a relative's farm or they may build in a swamp.

In 1941 the government began to enforce an old law providing that no corporation may own more than 500 acres of land. It set up a program of land purchase and settlement. In some cases a farmer is aided in borrowing money to buy land, and experts help him in farming it. Small plots are

NEW HOUSING AND A BUSY STREET IN SAN JUAN



At the left is one of the giant housing projects erected in the capital since the second World War. The city has grown rapidly as new industries have been established. Efforts are being made to clear the slums. At the right, modern automobile traffic crowds a narrow street in the old city. Notice that signs may be in English or Spanish.

assigned to squatter families so they can build a house and plant a garden.

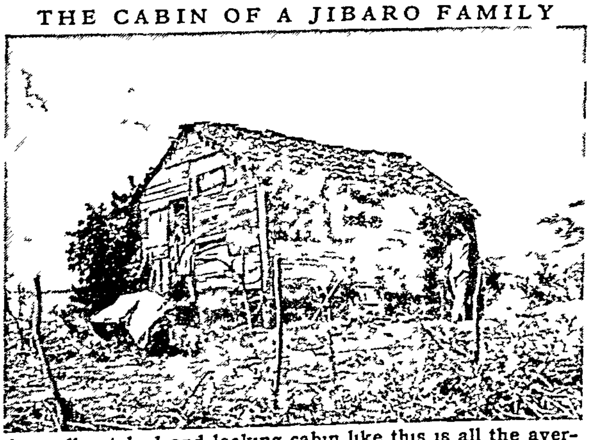
Housing is a problem in the cities too. The well to do and the few middle-class people have brightly painted houses built in the Spanish style. But the mass of the people are huddled together in small, crowded buildings without plumbing or sewer facilities. In recent decades the government and private construction firms have built large housing projects.

Agriculture, Industry, and Trade

Under Spanish rule, the three export crops—coffee, tobacco, and sugar cane—were of almost equal importance. But after 1898, the island's sugar could enter the United States without paying duty, and cane raising increased rapidly. It occupies one third of the cropland, while coffee and tobacco raising have decreased. Other commercial crops include coconuts, pineapples, sea-island cotton, grapefruit, citron, and vanilla. Truck farms raise vegetables for the city markets and ship some winter vegetables. Stock grazes on rough, unirrigated areas in the south.

Sugar cane processing, sugar refining, and the distilling of rum from the molasses make up the island's leading industry. Second in product value is the needlework industry. Much of the work, embroidery, needlepoint, hand finishing, and the like, is done by women at home. In recent years factories making underwear, blouses, gloves, and other clothing have increased. For many years manufacturing was virtually limited to these industries.

THE CABIN OF A JIBARO FAMILY



A small patched and leaking cabin like this is all the average farm worker can afford for his big family. It stands near the cane field and has no plumbing or sewer facilities.

Puerto Rico's foreign trade is extensive, since it sells most of what it produces and buys manufactured goods and more than a third of its food abroad. Sugar makes up three fifths of its exports. Some 90 per cent of its external trade is carried on with the United States.

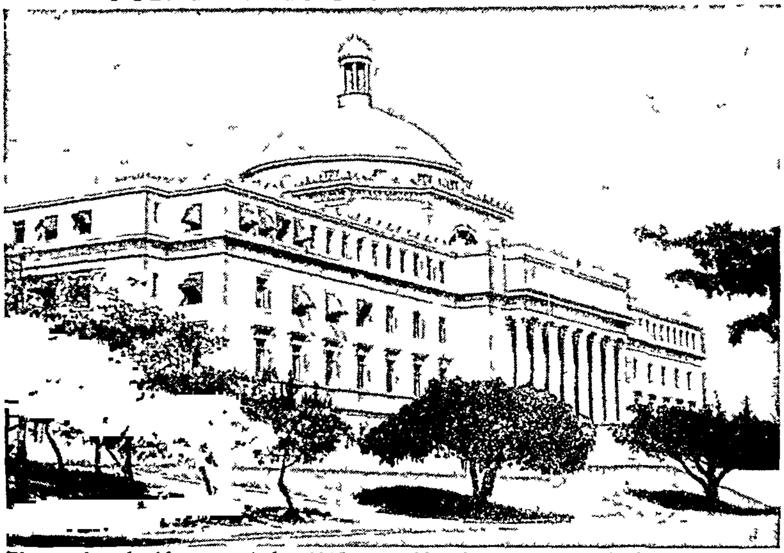
New Industries and Jobs

To supply jobs and goods for the people the island government set up the Industrial Development Company in 1942. This agency first built large cement, ceramics, glass-container, paperboard, and shoe plants and set them in operation to prove that factories could be successful. In 1947 it offered tax exemptions for 12 years to firms establishing new industries. By 1951 more than one hundred new plants had begun operation. The products included textiles, chinaware, clothing, hosiery, buttons, television and radio sets, candy, paper bags, and various novelties.

The government also pushed a water-development program to supply dependable hydroelectricity for manufacturing and to increase irrigation, city water supply, and sanitation facilities. The huge Coanillas Dam in the southern mountains was finished in 1948.

Puerto Rico's balmy climate and beautiful scenery attract tourists and winter visitors. The Development

PUERTO RICO'S CLASSICAL CAPITOL



This modern building, erected in 1925, resembles the government buildings in Washington. It contrasts with the ancient governor's palace, La Fortaleza, built by the Spaniards 300 years ago and restored by the Work Projects Administration in the 1930's.

Company has built hotels and promoted sports and recreation facilities to entertain them.

The island has excellent airline and ship connections with the United States and the Latin countries, and railroads around the coastal plain serve many large and small harbors. Highways crisscross the island, joining the cities and providing outlets for farm produce. More than 2,000 miles are paved.

San Juan and Other Cities

Puerto Rico's largest cities (1950 census) are San Juan, the capital (224,767), Río Piedras (132,438), Ponce (99 492) and Mayaguez (58,944). San Juan lies on an island off the north coast. On the nearby mainland stretch residential sections and suburbs. The city has an Old-World charm, with narrow streets and plazas, trees and exotic flowers, churches, castles, and fortifications. Tall business and government buildings and hotels strike a modern note.

Río Piedras is a residential and manufacturing suburb and seat of the University of Puerto Rico. Ponce, a south coast port, is the trade center for a rich irrigated district and has varied industries. Mayaguez, on the west coast, is the center of the needlework industry.

Educating for Literacy and Skill

Since the United States took over the island great stress has been laid on schooling. Illiteracy in the population has dropped from 79 to about 30 per cent. About one third of the government budget goes for education today, yet only about three fifths of the school-age children attend school. Country children are fortunate if they finish the four-grade first-unit school. Second-unit schools offer courses in elementary agriculture, handicrafts, domestic science, and some industrial arts and trades. Towns and cities have elementary, high, and vocational schools.

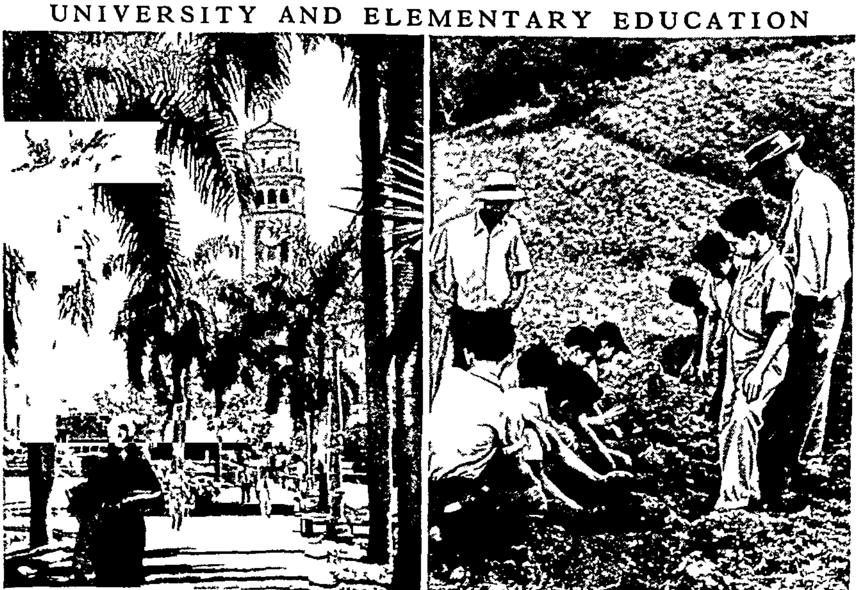
To the University of Puerto Rico falls the task of training teachers and other professional and technical workers. Its School of Industrial Arts was opened in 1948 to prepare skilled workers for new industries. The medical school, founded in 1951, incorporated the School of Tropical Medicine. Other colleges on the island include the Polytechnic Institute and the College of the Sacred Heart.

History and Government

Juan Ponce de Leon brought the first Spanish settlers to the island in 1508 and became its governor in 1509 (*see* Ponce de Leon). After they had exhausted the few gold mines, the colonists turned to agriculture. They imported Negro slaves to do the work.

To defend the island against Spain's enemies and against pirates of the Spanish Main, they built forts at the entrance of San Juan harbor—Morro Castle and San Cristobal. Sir Francis Drake failed to take them in 1595. The English captured the city in 1598

UNIVERSITY AND ELEMENTARY EDUCATION



At the left is a palm-shaded walk on the beautiful campus of the University of Puerto Rico at Río Piedras. It leads to the general administration building and Roosevelt memorial tower. At right, a group of boys in a second-unit country school practise agricultural methods on the school farm. The pupils share the crops they raise and supply their lunchroom.

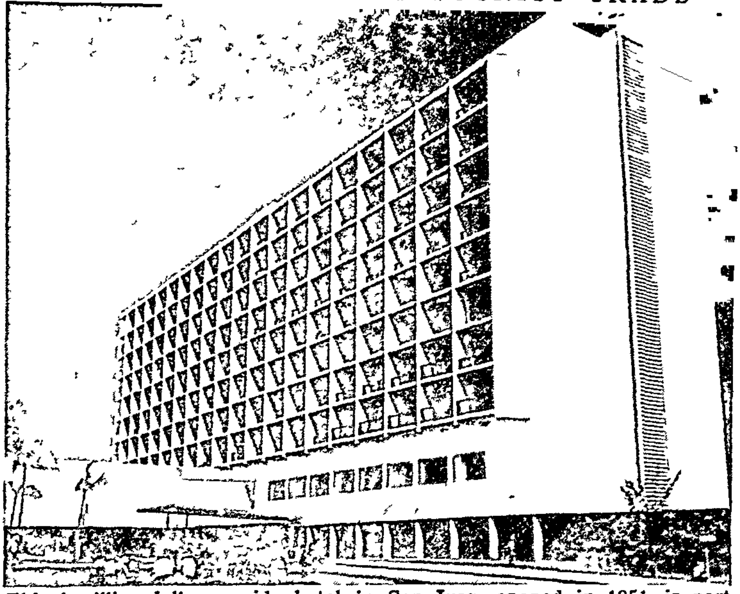
and the Dutch in 1625, but could not take El Morro. Slavery was abolished in 1873.

The Puerto Ricans revolted half-heartedly against Spanish rule in 1823 and again in 1868 and won virtual home rule in 1897. After the island fell to the United States, it had military rule until the Foraker Act of 1900 instituted civil government. The Jones Act, a new organic act, passed by Congress in 1917, conferred American citizenship on the people, gave them more home rule, and made the island an unincorporated territory of the United States.

During the second World War the United States built new Army, Navy, and Air Force installations to strengthen the island as the keystone in its Caribbean defense. Puerto Rican troops fought in this war and in the war that began in Korea in 1950.

In 1947 the Puerto Ricans won the right to elect their governor. They also vote for members of their Senate and House of Representatives and for their resident commissioner. The commissioner represents them in Congress but has no vote. The first popularly elected governor, Luis M. Marin, took office Jan. 2, 1949. On July 3, 1952, the United States approved a new constitution. This gave home rule to Puerto Rico as a commonwealth of the United States. The Puerto Rican lower house reaffirmed this status in 1954.

LUXURY TO ATTRACT TOURIST TRADE



This 6-million-dollar seaside hotel in San Juan, opened in 1951, is part of the government scheme to attract visitors and their money to the island. It is designed to catch the cooling trade winds. Each room has a balcony.

PULAS'KI, CASIMIR (1748–1779). Among the soldiers of Europe who aided the Americans in their struggle for independence was Count Pulaski, a Polish nobleman. In his own country Pulaski had taken part in the struggle to keep Poland free from Russian domination. The struggle had been unsuccessful, and Pulaski had been exiled in 1772. He escaped to Paris, where he met Benjamin Franklin. Franklin persuaded him to aid the colonies in their struggle for freedom, and in 1777 Pulaski joined the American Army.

He immediately distinguished himself at the battle of Brandywine and for his bravery was commissioned a brigadier general. He served for some time under Washington and then was given permission to raise an independent corps, which became known as "the Pulaski Legion." At the head of this force he successfully defended Charleston from an attack by the British in May 1779. But in an unsuccessful attack on Savannah, Ga., in October of the same year, he fell mortally wounded and died two days later. Though he had been unable to preserve liberty in his own country, he had helped to win it for a new nation.

PULSE. The phenomenon known as the pulse is due to the wavelike motion with which blood flows from the heart, causing distention and contraction of the elastic-walled arteries (*see* Heart). The word is from the Latin *pulsus*, meaning a "stroke" or "beating." In human beings, the beat of the pulse is usually counted at the radial artery in the wrist, since the artery there is near the surface and is easily compressed against the bone.

The pulse itself is unimportant. It might be called a by-product of the fact that the heart beats rhythmically and the arteries are elastic. However, by studying the pulse the physician can learn something about the condition of the heart, blood pressure, and blood vessels.

The pulse rate, which corresponds to the rate of the heartbeat, is the number of pulsations a minute. The normal rate for adults is from 67 to 72, but there is considerable variation even among people in good health. The rate is usually a few beats higher in women than in men. The rate is faster in children than in adults.

PUMA. Occasionally when forest rangers in the Rocky Mountains are riding back through the darkness to their lonely cabins, they are startled by a blood-curdling scream like the cry of a woman in mortal terror. It is the voice of the puma or mountain lion. Few persons, however, have heard the puma's cry, for it is the quietest of the cat family. It usually hunts silently, flitting like a shadow on the trail of a deer or springing without a sound upon a strayed calf, colt, or sheep.

Next to the jaguar of South America, the puma is the largest of all American cats. Formerly it ranged from ocean to ocean and from Canada to Patagonia. The early pioneers called it "panther" or "painter" and dreaded it as a fierce and treacherous beast. In the United States pumas have now disappeared from all but the wildest portions of the West.

Though the puma is a bloodthirsty killer of sheep and other small domestic animals, it becomes tame and docile in captivity. Puma kittens at birth are covered with spots and stripes, but these soon disappear to make way for the uniform reddish-brown color of the parents. The body of a full-grown male puma may be from four to five and one-half feet long, and its tail from two to three feet more. The female is

considerably smaller. Other common names for the puma are American lion, catamount (also applied to the lynx), and cougar. Scientific name, *Felis concolor*. (For illustration in color, *see* North America.)

A PUMA SHARPENS HIS CLAWS

Like the house cat, the puma delights in scratching trees to exercise its claws. But photographs showing this habit are rare, for the puma is a timid animal.

PUMP. Each of us has a marvelous pump—a beating heart—working for us as long as we live. What is a pump? It is a machine for moving fluids, ordinarily for lifting liquids. Among the earliest and simplest devices made by men for the purpose were probably the well sweep and the bucket raised by a rope over a windlass. The Persian wheel or *noria*—a wheel placed upright with the lower portion of the rim submerged in the water, and with buckets so hung all around the rim that each in turn, as the wheel revolves, dips up water and then pours it out on a higher level—is another device. It has been improved into the chain pump, in which the buckets are carried on an endless chain traversing two wheels, one down in the water and another on an upper level.

How a Suction Pump Works

A much later invention is the suction pump, by which water is first pushed up through a tube by air pressure or suction (*see* Air), and then lifted by the bucket or plunger. From the pumphead down into the water runs an airtight tube. The pump head is provided with a spout and a handle which by means of a plunger-rod works a plunger up and down in the tube. This plunger fits the tube closely; on its upper surface it carries a valve hinged to open upward. Fixed in the lower end of the tube is a similar valve.

When the handle is raised, pushing the plunger down, the pressure of the confined air opens the plunger valve but holds the lower or inlet valve shut. When the handle is forced down, raising the plunger and increasing the space between the two valves, a partial vacuum is created, and the pressure of the rarefied air within no longer balances the pressure of the air without. The weight of the outer air pushes the plunger valve shut and raises the water in the pump, opening the inlet valve. So by successive strokes the water is raised until it stands above the plunger, and is lifted to pour out at the spout.

It is atmospheric pressure alone that raises the water until it passes the plunger valve. For this reason the suction pump can raise a column of water only to a point at which the weight of the column is equal to the pressure of the atmosphere. This, at sea level, is about 32 feet; and because all pumps leak more or less the practical limit is about 25 feet. If water must be raised to a higher level, some other form of pump must be used.

The Force Pump

The simplest of these is the force pump, which may be simply a suction pump provided with a delivery pipe and a third valve, instead of a spout. Since the water above the plunger is lifted, not pushed up by the air, it may be lifted to any height by the addition of the third valve to prevent backflow. An air cushion is commonly added to equalize the flow of water. When the plunger is lifting water, the air is compressed; when the plunger descends, the compressed air expands and presses the water up through the delivery pipe, thus securing a steady stream of water.

These pumps are wonderful inventions; but innumerable varieties of far more complicated pumps are now in use. There are many varieties of the force and suction pump; many kinds of impeller pumps, including centrifugal pumps, aspirators, and injectors; impulse pumps or hydraulic rams (*see* Hydraulic Machinery); and many kinds of power pumps.

PUMPKIN. Pumpkin pie takes equal rank with turkey and cranberries as a part of Thanksgiving dinner. The earliest settlers in America found the Indians growing this big squash-like fruit between their rows of corn. When other crops failed the Pilgrim housewife learned to cook pumpkins. One hungry poet in 1630 sadly wrote:

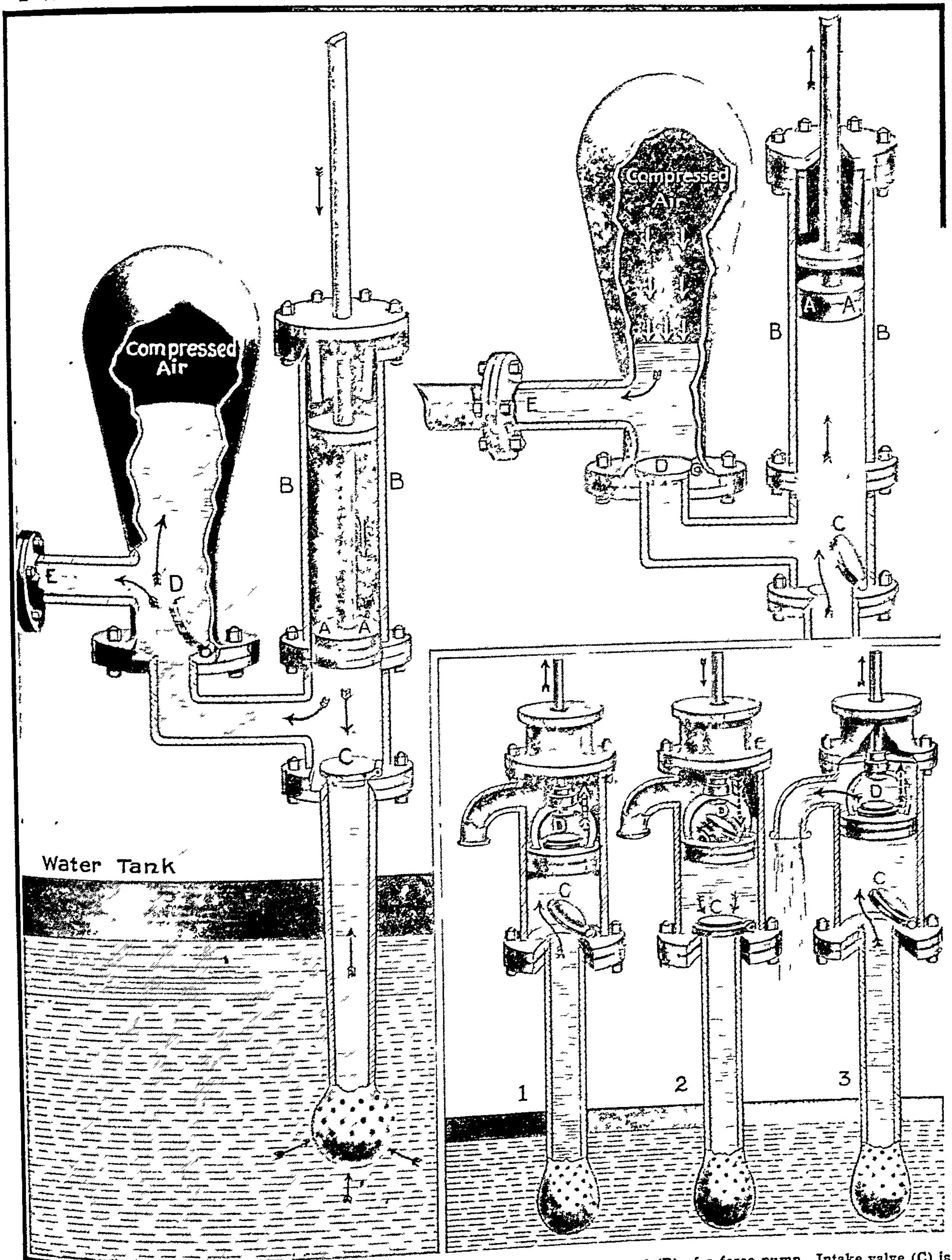
> We have pumpkins at morning and pumpkins at noon.
> If it was not for pumpkins we should be undone.

The first pumpkins probably grew in Peru. From there the plant spread throughout the Americas, and it was introduced into Europe. The Indians of Central and South America still consider it an important food. They prepare the pulp in many different ways. They also roast or salt the seeds and grind them into meal. In the United States raw pumpkins are used for livestock food and for Hallowe'en jack-o'-lanterns. They are also canned.

The coarse vine of the common field pumpkin grows to a length of 20 feet or more. It has large leaves, hollow five-sided stems, and large yellow flowers. The fruit weighs between 10 and 40 pounds. Pumpkins turn from green to yellow as they ripen, and are ready to harvest in late fall. (*See also* Squash.)

PUNCTUATION. A misplaced comma once cost the United States government $2,000,000. In a tariff bill some years ago the section enumerating what

TWO WAYS IN WHICH PUMPS RAISE WATER



The large left-hand drawing shows the downward stroke of the piston (A) in the barrel (B) of a force pump. Intake valve (C) is closed, and water is passing through the outlet valve (D) to the discharge pipe (E), and into the air chamber. In the upper right-hand picture an upward stroke is drawing water through the intake valve (C). The outlet valve (D) is closed and the air compressed in the air chamber by the last "down" stroke is maintaining the flow. In the pictures below the rising piston of a suction pump (1) is drawing water through intake valve (C). On the downward stroke (2) this valve shuts, and the piston valve (D) admits water to the cylinder. The next upward stroke (3) discharges this water and draws up more.

articles should be admitted free of duty specified "all foreign fruit-plants," etc., meaning plants for transplanting, propagation, or experiment; but a clerk in copying the bill changed the hyphen in the compound word "fruit-plants" to a comma, making it read, "All foreign fruit, plants," etc. The consequence was that for a year, until Congress could remedy the blunder, all oranges, lemons, bananas, grapes, and other foreign fruits were admitted free of duty.

Many a lawsuit has turned on the question of punctuation. One such occurred in France, where the disposal of $40,000 depended on the decision as to whether a small spot of ink was or was not a comma. For a less serious example, you know the nursery rhyme which reads, unpunctuated:

Every lady in the land
Has twenty nails on each hand
Five and twenty on hands and feet
This is true without deceit.

Now read the same properly punctuated:

Every lady in the land
Has twenty nails; on each hand
Five, and twenty on hands and feet
This is true without deceit.

Another instance of the difference made by merely interchanging two marks of punctuation is the story of a member of a legislative body who had called one of his fellow members a liar, and was compelled publicly to apologize. He did so by saying: "I said he was a liar, it is true; and I am sorry for it." The apology was deemed sufficient; but in the newspaper next day the apology was printed thus: "I said he was a liar; it is true, and I am sorry for it."

The ancient Greeks and Romans did not use punctuation; in very early times they did not even separate words in writing. If you try to read one of their manuscripts, you will realize how much easier it is to read a page that is properly punctuated.

Manutius, a 16th-century Venetian printer, is generally regarded as the originator of modern punctuation. These are the principal marks and their uses:

Period (.): at the ends of sentences and generally at the ends of abbreviated words.

Comma (,): to separate two halves of a compound sentence; words or phrases in a series; nonrestrictive clauses or phrases from the main part of the sentence; generally to establish clarity of meaning.

Semicolon (;): to separate elements requiring more marked division than indicated by comma.

Colon (:): to introduce quotation or long series.

Dash (—): to indicate break in thought.

Question mark, or interrogation point (?): to denote a question.

Exclamation point (!): to denote surprise, enthusiasm, or any emotion.

Hyphen (-): to divide certain compound words and to divide any word (with two or more syllables) at the end of a line.

Apostrophe ('): to denote possessive case and to mark omission of letter or letters in a contraction.

Parentheses (()): to set off elements in a sentence which are explanatory but independent of the structure of the sentence.

Quotation marks (" "): to enclose the actual quoted words of a speaker; also to enclose colloquial or slang words. Always used in pairs.

Single quotation marks (' '): to enclose quotation within a quotation; also to enclose title of book, play, short story, or poem. Always used in pairs.

There are numerous rules for the use of these various points, but perhaps no two writers or printers would agree as to the proper mark to be used in all cases. Good judgment and taste, and a certain amount of practice, are essential to anyone who would punctuate in such a manner as to secure the fundamental object of punctuation—the correct expression of the sense. When in doubt about punctuation, ask yourself this question, "Is a comma or other point needed to make the meaning perfectly clear?" Remember that there is always a reason for every mark of punctuation.

PUPA (*pū'pȧ*). This is the third of the four stages through which an insect usually goes during its lifetime, the first two being the egg and the larva stages. At the close of the larva stage the insect fastens itself firmly to some object and generally builds a cocoon or case about itself, made of silk or some other substance produced by little glands in its own body. In this cocoon it sleeps, either entirely motionless, as though dead, or squirming a little only when disturbed. During this sleep great changes go on within the body of the pupa, so that when it comes out it is quite a different-looking creature from what it was when it began its pupal sleep. It has now become a full-grown insect, and usually has wings. This wonderful change in form can be best seen when a caterpillar goes into its cocoon, transforms, and comes out a magnificent moth or butterfly. The pupal stages of some insects have particular names. That of the butterfly is called the chrysalis (*see* Butterflies). Only those insects which have what is called complete metamorphosis pass through the pupal stage. (*See also* Insects; Larva.)

PUPIN (*pū-pēn'*), MICHAEL IDVORSKY (1858–1935). A crowd of newsboys on New York City's Broadway was laughing and jeering at a 15-year-old lad who had just come from Serbia. They were amused at his queer clothes and the red fez on his head. Suddenly a boy knocked off the fez. The immigrant lad jumped at the bully, wrestled him to the ground, and got his fez back.

The boy who fought so well was Michael Idvorsky Pupin, and this was the first of many victories he won in his new home against staggering odds. His courage and intelligence finally carried him to high honors as physicist, inventor, teacher, and author. Among his inventions was the method of tuning used in every radio receiving set.

Pupin was born Oct. 4, 1858, in the Serbian village of Idvor, which is now in Yugoslavia. His peasant parents encouraged him to study in the local schools

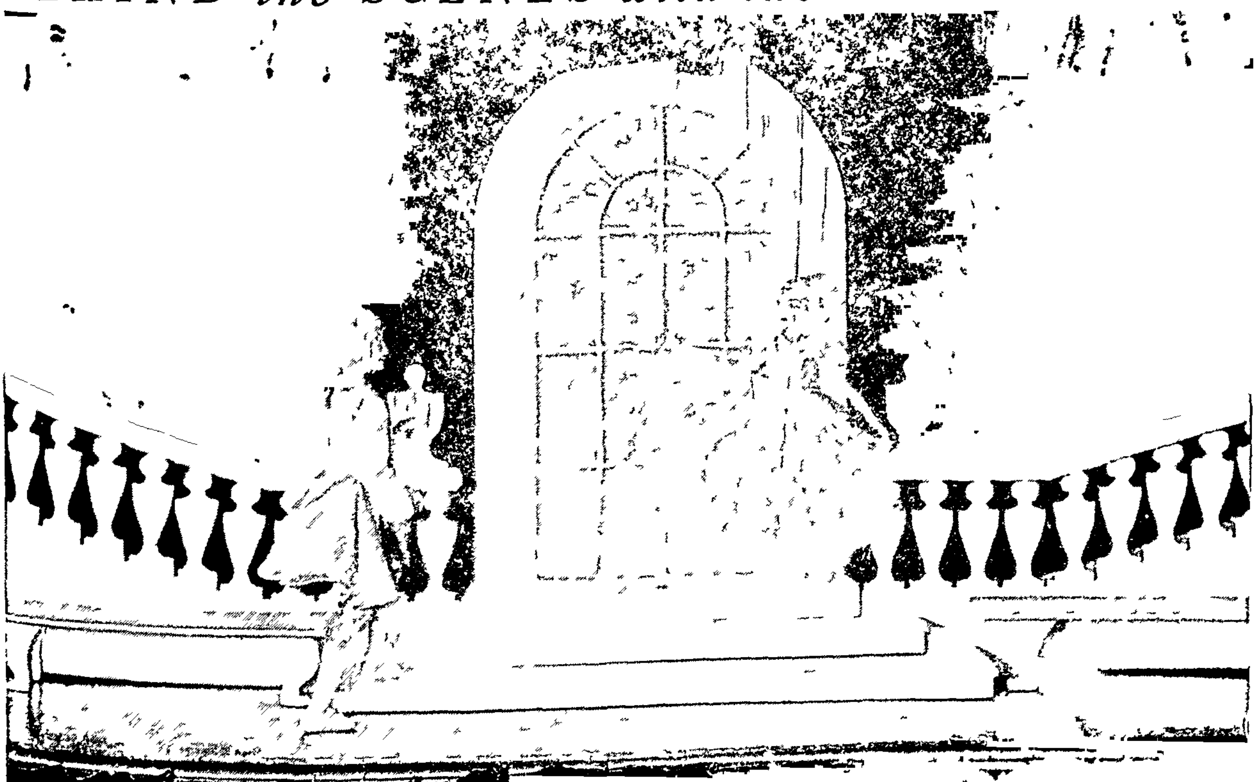
and later at Prague. At 15 he set out for the United States, where he could enjoy the freedom denied his people under the oppressive rule of Austria-Hungary.

When Michael landed, he did farm work and odd jobs, and later worked in a cracker factory. In his spare hours he studied at Cooper Union and elsewhere. In 1879 he entered Columbia College, where he earned his way by tutoring, giving instruction in wrestling, and other work. The day before his graduation in 1883, he took out final naturalization papers.

Having decided to make physics his lifework, he went to Cambridge University later that year to study mathematical physics. When Columbia awarded him its first John Tyndall fellowship in 1885, Pupin was enabled to attend the University of Berlin to work under the great physicist Hermann von Helmholtz.

In 1889 he returned to Columbia University and taught physical sciences there until he retired in 1929. His teaching helped inspire several pupils to become famous men of science, notably Edwin H. Armstrong, inventor of the regenerative radio circuit; and Robert A. Millikan and Irving Langmuir, who later won Nobel prizes. In 1892 he invented his radio tuning device. His most important invention was the loading coil (often called the Pupin coil), which made long-distance telephony possible. It brought him a fortune. He is also credited with making the first X-ray photograph in America and with the discovery of secondary X-ray radiation. Several universities gave him honorary degrees. Success in a foreign land did not lessen his devotion to his own people, and he gave freely to help Serbians in both Europe and America. He died in New York City, Mar. 12, 1935. His best-known book is his autobiography, 'From Immigrant to Inventor' (1923). Others are 'The New Reformation' (1927) and 'Romance of the Machine' (1930).

BEHIND *the* SCENES *with the* DOLL ACTORS



A charming scene from Sue Hastings' marionette production of the Cinderella story. If you look closely, you can see some of the strings by which the marionettes are made to gesture and move over the tiny stage with every appearance of life.

PUPPETS AND MARIONETTES. As long ago as a thousand years before the birth of Christ, puppets were as popular as picture shows are today. Once upon a time, the story runs, a Chinese emperor named Muh called in a famous puppet showman to entertain him and his many wives. The showman, Yen Sze, puffed up at being invited to exhibit at the royal palace, went happily to work and made a wonderful set of puppets that could open their lips, move their hands, and roll their eyes at the audience

But when Yen Sze put on his performance at court, the puppets seemed so real as they flirted with the imperial ladies that the Emperor flew into a jealous rage. He ordered Yen Sze's head chopped off on the spot. The miserable showman begged for his life. The Emperor declared stubbornly that Yen Sze had to die. It was only when the showman tore his puppets into shreds that the Emperor realized that he had been made jealous by mere scraps of colored paper and strings. Then the Emperor relented and gave the

showman his life. Not all puppets are as convincing as Yen Sze's, but they have had a long and exciting career as actors in almost every part of the world.

The name puppet comes from a Latin word meaning "baby" or "doll." "Marionette," some authorities say, comes from an Italian word meaning "clown" or "fool." Others think it may have come from "mariolette," the name for a little image of the Virgin Mary.

It is not known certainly where puppets originated. Some think it was in India. At least they were beloved there hundreds of years before civilization reached Europe. The Hindus of that far-off time believed that puppets had lived with the gods before coming down to earth, and accordingly they treated them with love and reverence. They carved lifelike images of pure gold, which they dressed in rich silks and gems. Legend says that they even trained starlings to speak the words of the plays, and imprisoned them in little cages in the puppets' throats to carry on the dialogue.

ALICE WITH TWEEDLEDUM AND TWEEDLEDEE

"If you think we're alive, you ought to speak." An episode from Sue Hastings' 'Alice in Wonderland'. This closeup shows clearly how the strings are attached to the little actors.

Ancient Egypt had its puppets, too—little movable figurines of gold which women carried in sacred processions. Today explorers, in opening the tombs of Egyptian children, sometimes unearth clay puppets that may have been loved by the playmates of Moses.

In Greece puppet showmen jogged along the roads to entertain the populations of Sparta, Thebes, and Athens. When the Romans conquered Greece, they carried some of the puppeteers to Italy, where they became tremendously popular. From Italy, puppet troupers trudged the muddy trails of Europe in the Middle Ages, carrying their little actors to the fairs of what are now France, Germany, and England. In France the favorite character, as famous as Mickey Mouse today, was known as Guignol. In Germany it was Hanswurst or Kasperle who enchanted the audiences. In Holland it was Jan Pickel-Herringe, and in England Mr. Punch, with his hook nose and hunchback.

In England puppets were used first, however, to tell Bible stories in the churches. At Christmas time the little theaters would show the rising of the Star of Bethlehem, the journey of the Three Wise Men, and the Nativity. At Easter they enacted the Crucifixion and the Resurrection. At another season churchgoers could see St. George hack the head from the scaly Dragon. When the English Parliament closed the regular theaters in 1642, at the beginning of the Civil War, the puppet shows had their heyday. They fell heir to the wealth of plays that had been barred from the stage, and some of the former actors began speaking lines under the direction of puppet masters.

Among the many famous men who have delighted in puppet shows is the great German poet Goethe, who owned a toy theater when he was a child. One day he saw a puppet production of the old legend of Dr. Faustus, and from it took the theme of his greatest play. Shakespeare is said to have written 'A Midsummer Night's Dream' and 'Julius Caesar' with puppets in mind. Ben Jonson and Joseph Addison loved puppet spectacles and often mention them. Franz Joseph Haydn composed some charming music for marionettes. Oliver Goldsmith, so Boswell says, almost broke a leg one time trying to prove he could jump over a broomstick as gracefully as a puppet. In 1674 Paris could boast a puppet opera company, and Munich has long had a little theater built in a park expressly for puppet actors. It is called "Papa Schmidt's Theatre," for a famous puppet showman, and has a stock of a thousand puppet actors.

In modern times, Maurice Maeterlinck, the Belgian playwright, began writing plays for puppets. The Viennese writer Arthur Schnitzler is another who seized on the possibilities of puppet performers. Gordon Craig, one of the most influential figures in the modern theater, has said that marionettes can express the thoughts of writers much better than can actors

of flesh and blood. These are among the men who were responsible for the awakening of a new interest in puppets in the United States, though there had been puppet plays in America long before. The Indians used marionettes in religious ceremonies centuries ago. Beginning in 1739, we have many tattered playbills to show that there were puppet performances of David and Goliath, the Burning of Rome, and Jack and the Wonderful Beanstalk, in America as well as in Europe.

But perhaps the Puritans did not approve of the wooden actors, for puppetry never really gained a foothold in the United States until 1915, when Ellen Van Volkenburgh and Maurice Browne staged a puppet performance in Chicago. Four years later, Tony Sarg sent out his first company, and in 1923 the Sue Hastings marionettes gave their first performance. From that time on, puppets have flourished.

Puppets are used not only for entertainment, but for educational purposes as well. In Russia for years the straggling puppet showman has been a familiar figure, with his hand organ, his monkey or bird, and his folding screen that housed a handful of bedraggled puppets. Now he has a fresh set of actors that are being used to teach political ideas to people who still have difficulty with the printed page. In many schools in the United States, puppet troupes help in the teaching of the social sciences, languages, handicrafts, and hygiene, as well as literature and dramatics.

Puppets have had a great deal of success in motion pictures, notably in the film 'I Am Suzanne' and in the Russian version of 'Gulliver's Travels'. They have been used successfully in stage revues and musical comedies. One of the interesting recent uses of puppets is in television broadcasts. They make excellent material for television drama because of their miniature size and the comparatively low production costs.

Three Kinds of Puppets

Puppets have been made of many different kinds of material—clay, wood, metal, cloth, leather, straw, and paper—and they are worked by all sorts of devices. They fall in general into three classes.

Guignol or *hand puppets* are made to slip over the hand, with a finger thrust into the head and one into each of the puppet's arms. For a play with only two characters, this type is ideal. Punch and Judy were almost always worked on the operator's hands.

Another type is the *rod puppet,* which is worked by a rod thrust up through the body, and other rods to control the various parts. The Javanese are especially skilled in the use of rod puppets. They are so fond of their beautifully dressed performers that they sometimes sit up all night to watch a play. Richard Teschner, a famous designer of exquisite puppets in Vienna, controls his strange, lovely figures with rods. For years there was a company of rod puppets in New York City. When 'Orlando Furioso' was presented, with about 400 puppets weighing nearly a hundred pounds apiece, the little actors fought so gallantly that the floor boards of their stage had to be renewed every two weeks. They performed for two hours or more every night and the complete cycle lasted 13 months!

The most common type of puppet in the United States at present is the one that is controlled by strings. This is usually called a *marionette,* to distinguish it from the hand puppet. The number of strings may vary from three to thirty, depending on what the operator expects his puppet to be able to do.

How to Make Puppets and Use Them in Plays

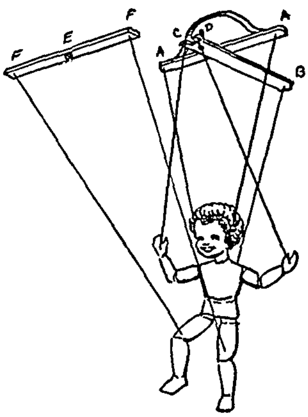
PROBABLY the easiest way to make a puppet is to take a rubber ball about two inches in diameter. Paint a face on one side and cut a hole in the bottom just big enough for the forefinger to slip through. Cut a hole in the center of a big handkerchief to serve as a costume. Fit the handkerchief over the hand, put your finger into the ball, and you have a puppet ready to perform. A darning egg may be used in the same way. Thrust the handle of the egg through the hole in the handkerchief and grasp it from below.

For string puppets, dolls and toy animals of soft cloth can be used. If ready-made dolls are used, however, part of the stuffing must be taken out to make them limber. Hollow out the stomach and stitch it across so that the puppet can move freely at the waist and sit down. Sew the arms and legs back on loosely. Stitch the elbow, ankle, and knee joints across twice about a quarter of an inch apart. Treat the neck in the same way. Weight the feet with shot or small pebbles so that the figure will stay down on the floor.

If you plan to make an entirely new puppet, then first draw a pattern on paper, in five pieces—for the trunk of the body, and for neck, arm, leg, and head. Allow a quarter of an inch on all sides for seams. Pin the paper parts together, and when you have adjusted them to look like the figure you have in mind, cut each piece on a fold of cloth. Seam, turn, and stuff each piece hard with cheap cotton, and weight the feet. Sew the arms and legs to the body, leaving the joints loose. The neck should not be stuffed, or the head will not nod or turn. Before sewing on the head, add crêpe hair, or hair made of string or darning cotton. The features can be drawn with crayon or sewed with embroidery floss. Dress the puppet before adding the strings. Attach strings to each hand, each knee, and each side of the head just above or behind the ears. Another string from the lower end of the spine will make the puppet bow.

Since you cannot hold all the strings without getting them tangled, you will need a "control." A simple type of control consists of three strips of wood about an inch wide, to which the strings are attached. To make it, you will need a pocketknife, tacks, wire, a few screws, and a strip of leather. The main control is

made by fastening two of the strips of wood together in the shape of a cross. Near the ends of the crossbar a leather strip is attached to make a handle through which the hand may be slipped. The free end of each string is attached to the control, as shown in the sketch below. Usually the string from the base of the spine is fastened to the lower end of the long arm of the cross (B) and the strings from the hands go to the upper end (C). The strings from the head go to the tips of the crossbar (A—A).



B—C is the long arm of the main control, and A—A is the fixed crossbar. The crossbar F—F has a hole E in the center so that it can be slipped over the peg D.

The knee strings are attached to a second crossbar (F—F). This is held in the hand when the puppet is walking. When not in use, it is slipped over a peg (D) on the main control to leave both hands free for working other strings.

The simplest stage is a high-backed, solid chair, preferably one with wings. Pin your scenery to the back of the chair and use the seat as a stage. The back will partially conceal you from your audience as you lean over it to operate the actors. When manipulating hand puppets, you can kneel in the seat of the chair and raise them into view over the back. Be careful not to let your wrists show below the costume.

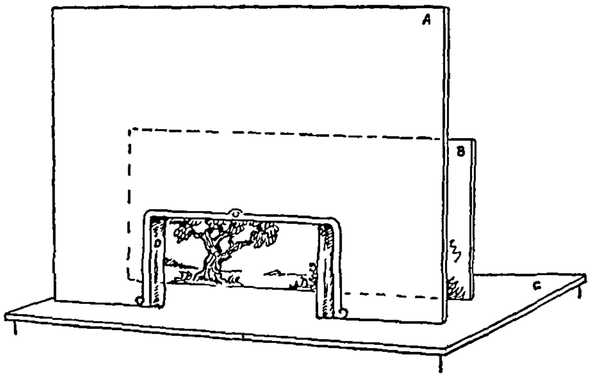
Another simple puppet stage is made out of a clotheshorse with three sides. Turn the middle section toward the audience, and the two sides extending back at right angles will conceal you. Cover all but the upper front section with paper or cloth; wallpaper is good, as it is gay, inexpensive, and can easily be renewed. Make a curtain for the opening or use a window shade cut to the right size. The words of the play can be written out and tacked to the inside walls.

For a more elaborate marionette stage, use a discarded doll's house, or a large box of wood or heavy cardboard. Settings and backdrops can be made of cardboard or pieces of cloth. For indoor scenes, paint or sew on doors, windows, and fireplace. For outdoor scenes, paint or sew on trees, flowers, or whatever else you need. The fewer the "properties," or pieces of furniture, on your stage, the less likely your marionettes are to become tangled. Christmas-tree lights can be twisted into footlights.

Since marionettes must be worked from above, it is a good idea to rest the stage on a substantial table that you can stand on. It is also a help if you can place the table in a draped doorway, so that the curtains will hide you from your audience.

Another form of puppet show is the shadow play, which is especially popular in China, Siam, and Java. All it requires is a sheet or screen of semitransparent material, a set of puppets cut from cardboard or cellophane mounted on cardboard, and a strong light. The light is placed behind the characters, which are worked from below by means of rods. The shadows are thrown on the screen while the showman speaks the lines.

Stretch the sheet across a door, blocking the lower part with furniture or heavier material. Behind it, set a desk lamp or floor lamp that has a strong bulb. Each piece of the puppets should be made separately. and the various pieces fastened together with brads. They are moved by stout wires attached to the different parts. The wires should be long enough to allow the puppeteer to keep his hands below the level of the transparent screen. Scenery can be cut out in miniature and placed immediately in front of the light, which will magnify it to the size of the screen. A sharper effect will be obtained if the scenery is cut to measure and tacked just behind the screen.



Cardboard is used for this simple stage setting. A is the front, or "masking," and B is the backdrop, on which scenery is painted or sewed. C is the top of the table and D is the curtain.

Many plays have been written for marionettes. Samuel French, Inc., lists puppet productions in its annual catalog. Books of plays and puppetry advice are also published by Paul McPharlin, Birmingham, Mich. But the most satisfactory puppet performances often come when the performer writes or dramatizes his own plays. (For list of books on marionettes, *see* Hobbies.)

PURE FOOD LAWS. Because health depends so largely on clean and nourishing food, governments have made laws since early times to prohibit the sale of adulterated foodstuffs and beverages. In the Middle Ages especially, many such regulations were imposed. In the United States the individual states took the lead in passing laws to prevent adulteration and to regulate the quality of food products. There was little national regulation, however, until Congress passed the Federal Food and Drugs Act of 1906. This was replaced in 1938 by the Federal Food, Drug, and Cosmetic Act, enforced by the Federal government through the Food and Drug Administration. The act applies to interstate commerce and to imports and some exports. The states have their own regulations.

Foods and beverages, for animals as well as for human beings, are subject to regulation under the Act of 1938. This law requires that labels tell if arti-

ficial coloring or flavoring or chemical preservatives have been added. All deceptive or misleading labeling is forbidden. Factories may be inspected to insure that conditions are sanitary, raw materials wholesome, and manufacturing processes satisfactory.

Drugs must meet federal standards of purity and strength. New drugs must be tested and reported to the government before being put on sale. Under a 1952 amendment to the Act of 1938 certain drugs are limited to sale on a doctor's prescription. They must be labeled: "Caution: Federal law prohibits dispensation except on prescription."

Devices designed to correct physical ailments are subject to rigid regulation. Harmful cosmetics are forbidden. Hair dye containing coal-tar color must have a label warning against use near the eyes.

PURITANS. "I will make them conform or I will harry them out of the land." This was the threat that King James I of England made to the Puritans when they asked him to "purify" the state church of England of certain ceremonies and usages derived from the Roman Catholic church, which they disliked. These Puritans were not dangerous revolutionists but just plain citizens of England—farmers, merchants, professional men, and scholars, especially from the University of Cambridge. They came to be regarded as gloomy fanatics, and it was humorously said that "they objected to bear-baiting, not because of the pain to the bear, but because of the pleasure to the spectators." The Puritans of the time of James I, however, were not afraid of innocent pleasure. Many of them were fond of music; the Puritan country gentlemen hunted; and the writings of one of the foremost Puritans, John Milton, have come down to us as a priceless literary heritage.

PURITANS ON THEIR WAY TO CHURCH

Going to church in New England in the early days wasn't a mere matter of getting up early enough on Sunday morning, for Indians might be lurking about anywhere. For years the settlers had to go in companies, as shown in this well-known painting by the American artist George H. Boughton.

The Puritans were the advanced wing of the Protestants in England in the days of the Reformation. The division began among the religious exiles from England who sought refuge on the Continent during the Catholic persecutions of Queen Mary's reign; and it became acute at Frankfort-on-the-Main in the quarrels between the "Knoxians" and "Coxians" (followers of John Knox and Dr. Richard Cox) over the wearing of priestly vestments. In general the Puritans inclined to follow the lead of Knox, Calvin, and the Swiss reformers, who would reject all usages of the Catholic church for which positive warrant was not found in the Scriptures, and would thus reduce the worship of their churches to the bare simplicity of Apostolic times. So arose their opposition to written prayers, religious images and pictures in the churches, instrumental music in the church services, and the like.

Some of the Puritans, instead of wanting merely to purify the church services, wanted to change the whole government of it as well. The Presbyterians, for instance, wanted to do away, "root and branch," with the government of bishops in the church, but would retain a state church. Others, called Separatists, or Independents, wanted the church and state to be entirely separated and each congregation to manage its own affairs; these were later called Congregationalists. Still more radical reformers called Anabaptists (or Baptists) thought baptism by immersion should be only for adults and held other unconventional views as to church and state.

It was a band of the Separatists who went first to Holland in 1608 and then to America in 1620, where they founded Plymouth Colony (*see* 'Mayflower'). James I and Charles I carried out the threat to "harry the Puritans out of the land," and thousands of others came to America, especially during the "Great Migration" of 1630–40. When the English Civil War gave the Puritans control of the government, the emigration stopped for a time. (*See also* Massachusetts; Charles, Kings of England; Cromwell.)

At the Restoration in 1660 the Puritans lost control of England, but the seeds of civil liberty and of a more serious outlook on life which they planted bore fruit in after-years. Not only greater freedom in religion but also greater freedom in government are among the things which we inherit from these Puritans, along with the literary works of Milton and Bunyan.

Since 1689, when a Toleration Act was passed, the English dissenting bodies have had a legal status, and today virtually no religious tests remain, except in the case of the crown.

PUTNAM, ISRAEL (1718–1790). One of the most adventurous heroes in colonial America was Israel Putnam. His skill as a woodsman is described in many popular legends. One of them tells that he crawled into a wolf's den and killed the animal at close quarters. His courageous feats as an officer in the French and Indian Wars and during the Revolutionary War won him renown as an American patriot.

Putnam was born Jan. 7, 1718, in Salem Village (now Danvers), Mass. He had little schooling, but he early learned the ways of the woods and streams. In 1739 he married Hannah Pope and moved south to Pomfret, Conn. At the outbreak of the French and Indian Wars he joined the Connecticut forces and was soon made a lieutenant. Later he became one of Rogers' Rangers. At one time he rescued a band of English soldiers from a strong force of Indians. At another he escaped capture by shooting perilous river rapids.

After the war Putnam farmed, ran a tavern, and became active in politics. In 1775 he was plowing a field when he was told of the battle of Lexington. He left his plow in the furrow and went to Boston to volunteer his services. He was appointed a major general in the Continental Army and was one of the leaders at the battle of Bunker Hill. (*See also* Bunker Hill.)

In succeeding engagements, his personal bravery was offset by his unwillingness to obey Washington's orders. During 1777–78 he commanded American forces along the Hudson River highlands. Here Washington strongly rebuked him for disobedience; but a court of inquiry exonerated him of charges against his fitness to command. In 1779 a paralytic stroke forced him to retire. He died May 29, 1790.

PUTTY. The material that holds window glass in place and keeps air from leaking around the panes is called putty. It is also used to fill small holes in woodwork. Putty is usually made by mixing *whiting* (powdered calcium carbonate) with boiled linseed oil into a tough dough. In open air it dries and becomes hard.

Jeweler's putty, used for polishing metals and glass, is powdered putty. *Iron putty* is a mixture of ferric oxide and boiled linseed oil; *red-lead putty* is a mixture of red and white lead and the oil. The last two are used for sealing joints in pipes.

PYGMY. Deep in the jungles of Africa and the Malay Archipelago are found a little people so primitive that they live almost like beasts. No one is sure what kind of people they really are or from where they came. Scientists generally place all Pygmy types in the Negroid group of mankind, but they differ in their opinions about the origin and relationship of the Pygmy stock. Some think that they may be racially the same as their larger neighbors; others suggest that the Pygmies all come from one primitive stock different from any other people now on earth.

The term pygmy is from the Greek word *pygme,* meaning "fist," which was used to indicate a measurement of 13½ inches. Most Pygmies are a little over four of these units in height. These small people are not stunted or deformed members of the larger races.

PYGMIES IN THE CONGO JUNGLE

Pygmies in the Ituri forest pose with a Bantu neighbor, who is normal size. Leaves cover their dome-shaped hut. Their caps are probably gifts of Mrs. Delia Akeley, who took the picture.

Physically and mentally they are rather like children. Their heads are large in proportion to their bodies, and their torsos are long and mounted on short, spindly legs. Though they are quick to understand, they have a short attention span. They are cheerful but highly emotional, and so shy that they are a curiosity even to most of their neighbors.

The African Pygmy tribes, known as *Negrillos,* live in the dense forests of equatorial Africa. Best known are the Akka, or Tikki-Tikki, who live along the Ituri River in the Belgian Congo. Some of them have learned to grow crops, but traditionally they are hunters and seminomads. The Asiatic Pygmies, called *Negritos,* include the Aeta of the Philippines, the Semang of the Malay Peninsula, the Tapiro of New Guinea, and tribes of the Andaman Islands in the Bay of Bengal.

All over the world Pygmies seem to live much alike and to be on nearly the same level of intelligence. Although the men spend a great deal of their time in search of game, they live chiefly on wild fruits and vegetables. They do no real work beyond gathering food and making their few simple tools. Few of them plant or cultivate anything. Even their houses are flimsy structures of woven twigs and leaves that can be built anew each time the tribe moves.

Their chief weapons, used almost entirely for hunting, are the bow and arrow, the blowgun, and the knife; sometimes the arrows are poisoned. Clothing is a simple matter, since Pygmies seldom wear anything but breechcloths or short skirts, usually of bark, grass, or leaves. Some tribes trade with their more civilized neighbors, exchanging forest products for knives, cloth, and ornaments.

Pygmies though shy are good-natured and cooperative. Each small tribe is made up of a few family groups, and all work together for the common good. Explorers say that Pygmies seldom lie, steal, or fight among themselves.

PYLE, HOWARD (1853–1911). "Everything must have a beginning," Howard Pyle once wrote, "and I often think that my beginning must have begun in a very bright and happy childhood." This famous American illustrator and writer was born March 5, 1853, in an old stone house in Wilmington, Del. His parents, William and Margaret Pyle, were both Quakers.

An intense interest in everything around him was part of his childhood. He loved books and the pictures in books. On winter days his mother, a great lover of art and literature, would sit by the fire telling stories about the pictures in books that as yet Howard could not read. Soon he knew Grimm's tales almost by heart and went on to 'The Arabian Nights' and other stories. Two brothers and a sister later shared the tales. "We children," he said, "did not have so many books as children have now, but what we had were good." The readings led to the great interest in tales of chivalry and adventure that later showed in his work.

At the old Friends' School Howard Pyle was not an especially good pupil, for he filled his slate and schoolbooks with pictures. His parents hoped he would go on to college; but he wanted to write and draw more than anything else. So he worked in the studio of Van der Weilen, a Dutch artist, in Philadelphia for three years. This training and some later courses at the Art Students' League in New York City made up Pyle's formal art training.

PYLE'S ROBIN HOOD AND FRIAR TUCK

Howard Pyle drew this picture for 'The Merry Adventures of Robin Hood' (Scribner's). He called the scene "The Merry Friar Carrieth Robin across the Water."

For a time he worked in his father's leather business. Then *Scribner's Monthly* accepted an article which he wrote and illustrated. The editor encouraged him to come to New York City. In 1876 he went to try his luck in the great city. The magazine editor, however, showed little further enthusiasm. Pyle's illustrations, so full of life and so different from the smooth, refined ones of the time, were thought by many to be "coarse and vulgar." His letters home told of deep discouragement, but he did not give up. For a while he wrote "little animal fables" for *St. Nicholas Magazine* and wrote and drew for *Harper's Young People's Magazine*. Some of these stories were later printed in his books 'Pepper and Salt' and 'The Wonder Clock'. He also did illustrating for Scribner's and Harper's adult magazines.

After three years Pyle decided to work at home. He returned to Wilmington, where he had a studio in his home. At a young people's chorus group he met Anne Poole whom he married in 1881. They had six children. In 1883 his famous book 'The Merry Adventures of Robin Hood' was published.

In 1894 Pyle began teaching art two days a week at the Drexel Institute in Philadelphia. Some of his pupils became well known—Violet Oakley, Jessie Willcox Smith, and Maxfield Parrish. In 1898 he established a summer school at Chadd's Ford on the Brandywine River. Two years later he resigned from Drexel and opened a school attached to his Wilmington studio. He took a few pupils who paid no fee but shared the expenses of the studio. Among these students was N. C. Wyeth, who became a noted illustrator.

A master of line drawing, Pyle brought a fresh spirit to the illustration of magazines and children's books. His publishers knew him as a dignified, serious man who was interested in every detail of printing and binding. With his family and students he was jovial and by no means always dignified.

Toward the end of his life Pyle became interested in mural painting. He went to Italy to study old masters, but he became ill and died in Florence Nov. 9, 1911. More than for his paintings he is remembered for his stories and for his magnificent illustrations for children's books. There were so many editions of 'Robin Hood' that the plates were almost worn out. Fortunately the original drawings were found and new plates were made. Late in life Pyle said, "My ambition in days gone by was to write a really notable adult book, but now I am glad I have made friends of the children rather than older folk."

PYRAMIDS. The three great pyramids of Egypt were already 2,000 years old when the ancient Greeks pronounced them one of the Seven Wonders of the World. Little or nothing remains of the other six wonders, but the mighty pyramids still endure. Even today there are no monuments more celebrated.

The pyramids are solid stone structures with a square base and triangular sides that meet at the top. The form seems to have been a symbol of Egypt's great sun-god, and it may have been regarded also as a kind of staircase to heaven. The chief purpose of the

gigantic structure was to protect the burial chamber of a king or queen; for the Egyptians believed that only by preserving the body could they be sure of an afterlife. The burial chamber was usually not inside the pyramid but under its exact center. A sloping tunnel led down to this chamber. After the burial, the entrance was plugged up with huge stone blocks. Nevertheless, grave robbers long ago forced their way in and emptied the tombs of bodies and treasures.

The Pyramids of Gizeh

For more than a thousand years the pharaohs of Egypt built their tombs in pyramid form. Archaeologists can identify about 80, but more than half of these are now little more than piles of sand and rubble. The three great pyramids stand near the town of Gizeh, on the west bank of the Nile, opposite Cairo. The largest, called the Great Pyramid, is the monument of King Khufu. The Second Pyramid was built for King Khafre. The Third Pyramid commemorates King Menkaure. These kings belonged to Egypt's fourth dynasty (2650–2500 B.C.). (*See* Egypt, Ancient.)

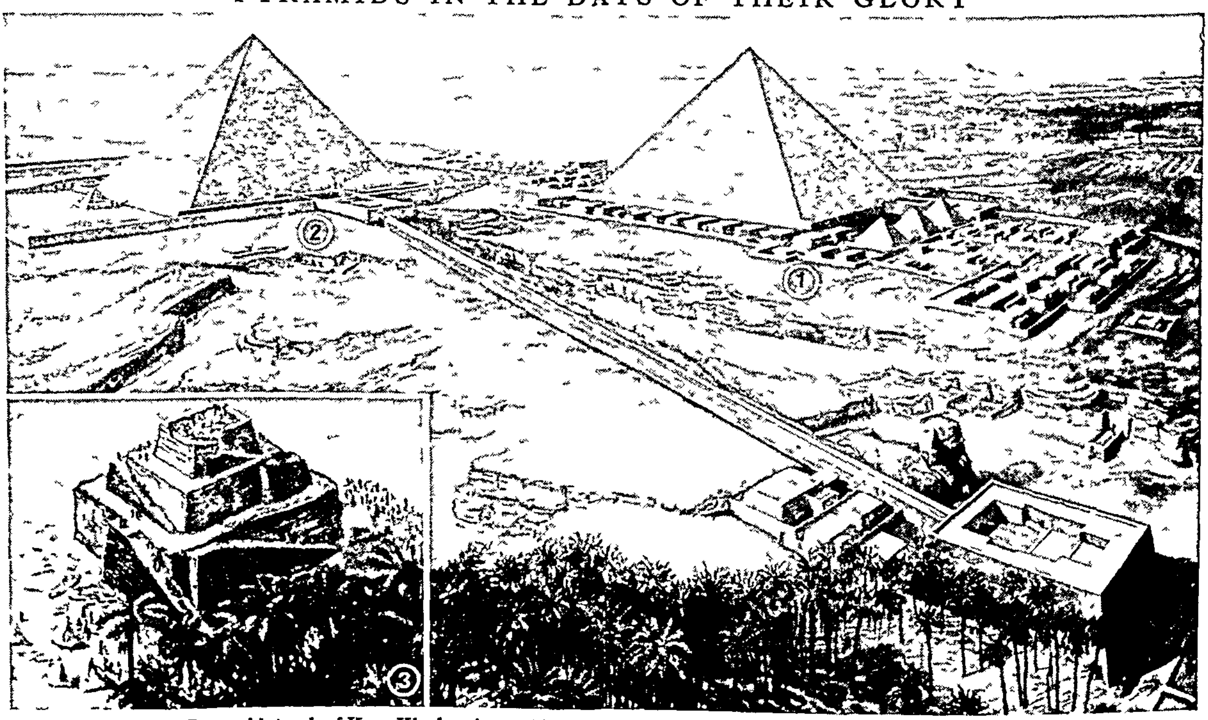
It is estimated that 2,300,000 blocks of limestone were used to build the Great Pyramid. The blocks averaged $2\frac{1}{2}$ tons each; the largest weighed 15 tons. The base covered 13.1 acres and the surface of each side was approximately 5 acres. The pile rose to a height of 481 feet. The top 31 feet are now missing and the outer limestone casing has been stripped off. (Local builders used to regard the pyramids as a handy source of cut stone.) The Second Pyramid was originally ten feet lower than the Great Pyramid. Today it is only $2\frac{1}{2}$ feet lower (present height, $447\frac{1}{2}$ feet). At the top it still retains its granite casing. The Third Pyramid covers only half the area occupied by the Great Pyramid. It is now 204 feet high.

How the Pyramids Were Built

When a new king came to the throne, he began at once to plan his tomb. If his reign was long, he might enlarge the original plan several times before the structure was completed. The first task was to choose the site. It must be west of the Nile, for the Egyptians thought of the home of the dead as lying to the west, where the sun set. It must stand on the rocky desert plateau, safe from the Nile flood but not too far from the river, because the stone was moved by ship. After the site was chosen, the rocky surface was leveled and a perfect square marked out. The sides faced almost exactly north, east, south, and west. While this work was going on, gangs of workmen were quarrying limestone at Tura, on the east bank of the Nile. They put on the stones such names as Sceptre Gang, Vigorous Gang, and Enduring Gang. Far to the south, at Aswan, other gangs labored in granite quarries. For quarrying limestone the Egyptians used copper chisels and wooden wedges. It is not known how they quarried the granite roof slabs, each weighing 50 tons, in Khufu's burial chamber.

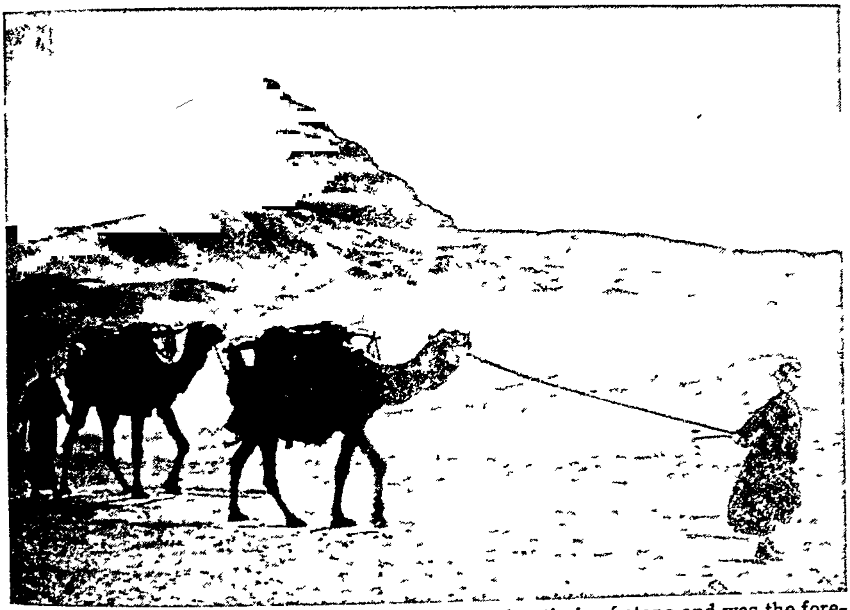
When the Nile flooded, the stone was loaded on rafts and floated to the pyramid site. For transport over land, the blocks were probably levered onto sledges

PYRAMIDS IN THE DAYS OF THEIR GLORY



1. This is the Great Pyramid, tomb of King Khufu. Around it are flat-topped mastabas, tombs of close relatives and officials. In front are three small pyramids, tombs of Khufu's queens. 2. The Second Pyramid, tomb of King Khafre, has a mortuary temple at its east face. Offerings of food and drink were left in this temple for the dead king. A covered causeway, one-quarter mile long, descends to the Valley Building, near the Nile. Behind this building lies the Great Sphinx, a lion with a human head. 3. This pyramid is in an early stage of construction. The ramps are used for hauling up stone. (From a reconstruction by Hoelscher.)

REMAINS OF THE STEP PYRAMID AT SAQQARA



This was the first great building in Egypt constructed entirely of stone and was the forerunner of later, smooth-sided pyramids. It was built by King Djoser's gifted architect, Imhotep, about 2815 B.C. The six steps carried it to a height of 204 feet.

and the sledges levered onto rollers. Scores of men dragged the sledges, pulling on ropes. The pyramid began as a series of steps. Temporary brick ramps were built to haul the stone up the side. As the pyramid grew, the ramps were made longer and higher. When the required size was attained, the steps were filled out with stone to make a smooth incline, usually of about 52°. Then a layer of casing stone was added. The final task was to smooth and polish the surface. It is estimated that a single pyramid required a labor force of about 100,000 men.

Mastabas, Step Pyramids, and Ziggurats

In very early times, the Egyptians buried their dead in sand pits. Later, to keep the covering sand from blowing away, they erected over the pit a solid rectangular structure of brick or stone. This type of tomb is called a *mastaba* (an Arabic word meaning "bench"). The mastaba was elaborated until it became a house for the dead with corridors and rooms adorned with inscriptions, painted reliefs, and statues. Nobles continued to be buried under mastabas when the kings were building pyramids. The earliest pyramid was a *step pyramid*. This was simply a pile of mastabas, each smaller than the one before.

The pyramid form of architecture is not peculiar to Egypt. The *ziggurats* of ancient Babylonia and Assyria were great mounds of sun-dried brick faced with glazed brick or tile. Some, like the Saqqara step pyramid, rose in three to seven terraced steps. Others had spiral ramps winding from base to flat top. Unlike the Egyptian pyramids, the ziggurats were not used as tombs. They served as bases for temples, altars, and astronomical observatories. The ziggurat at Ur, built about 2300 B.C., measures 220 by 150 feet at the base and rises in three stages to a height of 70 feet. Each stage was covered with glazed brick—black at the bottom, then red, then blue at the top (for picture, *see* Abraham). The great ziggurat of Borsippa, sister city of Babylon, was 272 feet square and 160 feet high, with seven stories, each colored with a different glaze to represent the seven divisions of heaven and earth.

Throughout Central and South America are many pyramids built by the Maya, Toltec, Inca, Zapotec, and other Indian peoples. Like those of Babylonia and Assyria, they served as bases for temples and altars. They are truncated step pyramids, faced with highly ornamented stucco over an earth and rubble foundation. Stairways on one or more sides led up the sloping sides. The enormous Toltec pyramid of Cholula, near the city of Puebla, Mexico, is only 177 feet high, but its extremely broad base covers more than three times the area of the pyramid of Khufu. Near Mexico City is the Pyramid of the Sun (for picture, *see* Mexico).

PYRENEES (*pĭr'ĕ-nēz*). A wall of mountains called the Pyrenees stands between France and Spain from the Bay of Biscay to the Mediterranean Sea. The average height of the peaks is about a mile above sea level, but in the central portion they range from 8,000 to 10,000 feet high. The highest, Pico de Aneto (or Pic de Néthou), is 11,168 feet high. The boundary line between France and Spain follows along the central ridge. The tiny republic of Andorra, with an area of 191 square miles, lies in a deep valley in the heart of the eastern chain.

Even in summer, snow and ice crown the peaks. On the French side, ocean winds bring rain and forests cover the slopes. The Spanish side is drier and the slopes tend to be bare and brown. On each side, however, snow-fed streams pour down through deeply cut valleys. In the eastern portion, the Spanish have harnessed the streams to provide hydroelectric power, particularly for Barcelona.

The principal railroads follow the seacoasts around the eastern and western ends of the range. Other railroads cross the central portion from Toulouse in France to Barcelona in Spain and in three other locations. A network of roads also attracts tourist travel on the French side.

The inhabitants are largely farmers and stock raisers who pasture cattle, sheep, and goats on upland meadows. There is some iron mining, and the Spanish side has coal deposits. Otherwise the Pyrenees offer little in mineral wealth.

PYROMETER (*pī'rŏm'ĕ-tẽr*). No type of thermometer can measure temperatures higher than 1,000° F. Higher temperatures must be measured with some kind of pyrometer. (The name is from Greek terms meaning "fire measures.")

In one common type, a junction between different metals is placed in an electric circuit. This junction, called a *thermocouple*, will generate current proportionate to its heat (*see* Electricity). It is made by winding together and fusing wires of two different metals. The unit is housed in a heat-resistant tube and placed where a temperature reading is wanted. The generated current is measured on a sensitive galvanometer which is marked to show temperatures directly.

For extremely high temperatures, a high-resistance couple is made of platinum and an alloy of platinum and rhodium. Lower temperatures can be measured with a low-resistance couple made from various alloys of iron, nickel, and copper.

The *electrical-resistance* type of pyrometer works on the principle that the conductivity (or oppositely, the resistance) of a platinum wire varies with its temperature. Variations in current created in a coil of wire wound upon a mica core are measured with a Wheatstone bridge. Such instruments give excellent readings of low temperatures.

Temperatures can also be determined by measuring the heat radiated from a hot surface. Some pyrometers of this type simply use a combination of thermocouples. A common *optical* type looks like a small telescope. Inside is an electric lamp, heated by a current with a control. The control is adjusted until the lamp matches the radiating surface in brightness. The current required to do this can be read from a scale which is marked for temperatures.

Seger cones are narrow pyramids about two inches high made of various substances, each of which has a definite melting point. By exposing different cones to the heat in question and noting the one which just barely melts, a reasonably close estimate of temperature can be made.

PYRRHUS (*pĭr'ŭs*), KING OF EPIRUS (about 318–272 B.C.). Early in the period when the city of Rome was spreading its rule over Italy, one of its most notable foes was King Pyrrhus of Epirus, a country in northwestern Greece. When war broke out between Rome and Tarentum, a Greek city in southern Italy, he accepted a call for help from the Tarentines, hoping to build an empire for himself. He crossed the Adriatic in 280 B.C., with about 20,000 men and some elephants, and fought the Romans at Heraclea.

The Romans had never seen elephants before, and the strange beasts helped Pyrrhus to win a bloody battle. His loss was so great, however, that he is said to have exclaimed, "Another such victory and we are lost!" From this, a costly victory is still called "a Pyrrhic victory." He won another such battle at Asculum, then retired to try his fortunes in Sicily, helping Syracuse against Carthage.

He fared no better here, and he returned to Tarentum, only to meet final defeat by the Romans at Beneventum (275 B.C.). He returned to Greece and became King of Macedonia. When he was called to Argos to settle a political quarrel he was killed by a tile thrown at him from a rooftop.

PYTHAGORAS (*pĭ-thăg'ō-răs*) (6th century B.C.). This famous religious teacher and mathematician was the first man to call himself a philosopher, for it was he who invented the word philosophy. Pythagoras migrated from his native island of Samos in Greece to Croton in southern Italy about 530 B.C. There he established a school, teaching his belief in immortality and the "transmigration of the soul." He held that after death any soul which did not go to heaven then occupied the body of another man or even an animal. He therefore prohibited the sacrificing or eating of animals.

His disciples, called Pythagoreans, were bound by many other rules of conduct. They had to observe silence and they could drink no wine. Because he believed that the bean was the first offspring of the earth when it was formed, he forbade them to eat beans. He also established mystic rites which they performed in the greatest secrecy for the purification of their souls. Continued persecution of the Pythagoreans in Croton forced their leader to flee to Metapontum in Greece. There he died about 500 B.C.

Pythagoras developed many theories which seem foolish today, but he also made some contributions to real knowledge. He formulated a theory of harmony when he discovered that the length of a musical string is in exact numerical relation to the pitch of its tone. This led him to believe that number was the first principle of the whole universe. He also taught the theorem, known by the Sumerians as early as 2000 B.C., that "the square on the hypotenuse of a right triangle is equal to the sum of the squares on the other two sides" (*see* Geometry). Pythagoras also insisted that the earth was round but large enough to seem flat everywhere on the surface. He came to this conclusion not from astronomical evidence, but on the basis that a sphere is the most perfect figure.

PYTHON (*pī'thŏn*). The tropical regions of Africa, Asia, and Australia are the haunts of the pythons, a group of huge and powerful serpents belonging to the same family as the boa. The reticulated python is a beautiful creature with a yellowish-brown body marked with iridescent black lozenge-shaped spots. It reaches a length of as much as 30 feet and is the largest snake found in the Old World.

Pythons are equally at home sliding through dense underbrush, climbing trees, or swimming. They kill their prey—chiefly birds, small deer, and other small mammals—not by poison-bearing fangs but by coiling their muscular bodies about the victim and crushing it. There are few records of pythons attacking man.

The python grows slowly and probably lives to an old age. The female lays about a hundred eggs, which she collects into a heap, then wraps herself about them until they hatch. During this strange incubation period she does not partake of food.

Besides the reticulated, or regal, python (*Python reticulatus*) of the Malay Peninsula, other well-known species are the West African python (*Python regius*), the Indian python (*Python molurus*), and the Australian diamond, or carpet, snake (*Python spilotes*).

THE EASY REFERENCE FACT-INDEX

GUIDE TO ALL VOLUMES FOR SUBJECTS BEGINNING WITH

P

TO SAVE TIME

USE THIS INDEX ☞

EDITOR'S NOTE ON NEXT PAGE TELLS WHY

SPECIAL LISTS AND TABLES

Numerous other lists and tables in the fields of geography, history, literature, science, mathematics, and other departments of knowledge will be found with their appropriate articles in the main text

EDITOR'S NOTE

EVERY user of Compton's Pictured Encyclopedia should form the habit of *first* turning to the Fact-Index section at the end of each volume when in search of specific information. This index is a miniature work of reference in itself and will often give you directly the facts, dates, or definitions you seek. Even when you want full treatment of a subject, you will usually save time by finding in the index the exact page numbers for the desired material.

All page numbers are preceded by a letter of the alphabet, as A-23. The letter indicates the volume. If two or three page numbers are given for the topic you are seeking, the first indicates the more general and important treatment; the second and third point to additional information on other pages. Where necessary, subheadings follow the entry and tell you by guide words or phrases where the various aspects of the subject are treated.

The arrangement of subheadings is alphabetical, except in major historical entries. In these the chronological order is followed.

The pictures illustrating a specific subject are indicated by the word *picture* or *color picture* followed by a volume indicator and a page number. A picture reference is frequently intended to call attention to details in the text under the illustration as well as to the illustration itself. This picture-text, therefore, should always be carefully read. The pictures are usually on the same page as the text to which you are also referred; sometimes they are found in a different but related article which will add interest and information.

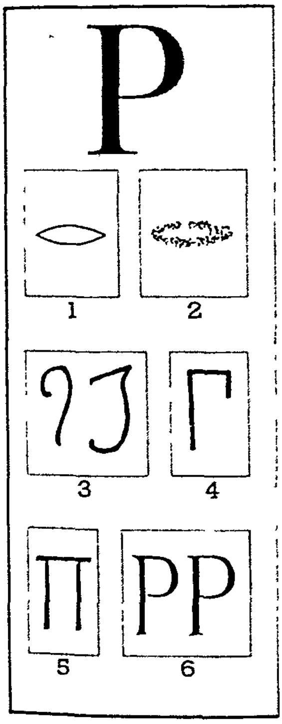
The pronunciations given are those preferred by the best and most recent authorities; alternative pronunciations are indicated where usage is divided.

In recent years hundreds of foreign geographical names have been changed, either officially or by custom. Both old and new names are given at the appropriate places in the alphabet.

Populations are those of the latest census or an official estimate when available if no census has been taken since World War II. Distances between points are map or air distances, not distances by railroad.

THE EASY REFERENCE FACT-INDEX

Reg. U. S. Pat. Off.



Our letter P probably started in ancient Egypt as a sign for the mouth (1). Soon after 2000 B.C., a Semitic people called the Seirites adopted it as an alphabetic sign for the sound of 'p', because the Semitic name for 'the mouth' began with this sound.

The Seirite sign (2) was much like the Egyptian; but later the Canaanite-Phoenician alphabet used a curved line, frequently with an angle (3). In Hebrew the sign was called *pe* (pronounced 'pay'), and other Semitic languages had similar names.

The next change came when the Greeks learned to write from the Phoenicians. The Phoenician sign was shaped to suit the Semitic fashion of writing from right to left: but, when the Greeks came to write from left to right, they turned the letter around and gave the right-hand stroke a little tail (4) to distinguish the sign from an early *gamma* (*see* the Fact-Index article on G). The Chalcidian Greeks who settled in Italy also used a sign with curved upper strokes. Later the Greeks gave the sign more symmetry by lengthening the tail. The resulting 'classic' form (5), called *pi*, has remained unchanged in Greek ever since.

Before this happened, however, the Romans had learned to use the curved Chalcidian letter, and they closed the small curve into the upright stroke. This created the Latin P (6), which passed into English without change.

Our handwritten small 'p' is a quickly made copy of the capital, and the printed small 'p' imitates the handwritten one.

Note.—For the story of how alphabetic writing began and developed, *see* the articles Alphabet; Writing.

Paca, William (1740–99), signer of Declaration of Independence; born Hartford County, Md.; governor of Maryland (1782–86); U.S. district judge (1789–99)
signature reproduced D-37

Paca, ground-dwelling rodent (*Coelogenys paca*); about 2 ft. long; color varies from fawn to black; longitudinal rows of light-colored spots; lives in burrows along river banks or in old tree roots; strong, rapid swimmer; found from Ecuador to Brazil and Paraguay; fur of no commercial value.

Pace, Frank (born 1912), public official and lawyer, born Little Rock, Ark.; served in World War II; assistant to U.S. postmaster 1946–48; assistant director 1948, director 1949–50, of U.S. Bureau of the Budget; secretary of the army 1950–53.

Pace, gait of horse, *pictures* H-428*f–g*

Pachmann (*päk'män*), **Vladimir de** (1848–1933), Russian pianist, noted for brilliant interpretations of Chopin's works; toured U.S.

Pachomius (*pa-kō'mi-ŭs*), **Saint** (292?–346?), Egyptian monk; established first monastery: M-354

Pachuca (*pä-chọ'kä*), Mexico, city 55 mi. n.e. of Mexico City; altitude 8000 ft.; pop. 58,658; capital of state of Hidalgo; silver mines, reduction plants: *maps* M-189, 195

Pachyderm (*păk'i-dûrm*), a semi-scientific term applied to the elephant, the rhinoceros, the hippopotamus, the tapir; from the Greek, meaning "thick-skinned": E-326

Pachysandra (*păk-i-săn'dra*), a genus of creeping plants of the box family, native to N. America and Japan. Both evergreen and deciduous, with small flowers, white, greenish, or purple, in spikes; used as a ground cover in gardens; one species called mountain spurge.

Pacific, College of the, at Stockton, Calif.; Methodist; founded 1851; arts and sciences, education, engineering, music; graduate studies.

Pacific bluestem wheat, *picture* W-116

Pacific Fur Company, organized by John Jacob Astor F-324

Pacific hake H-246

Pacific Islands P-1–19, *map* P-16–17, *pictures* P-1–3, 9–14, *color pictures* P-5–8. *See also in Index* names of chief islands and groups of islands
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Guam first discovered G-221
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Pacific Islands, Trust Territory of the, official name of former Japanese mandated islands (Marshall, Caroline, and Mariana islands except Guam) after transfer to strategic trusteeship of U. S. by agreement in 1947 with Security Council of United Nations; land area of trust territory, about 687 sq. mi.; native pop. 54,299: *map* P-16

Pacific loon L-314

Pacific Lutheran College, at Parkland, Wash.; founded 1890; opened as academy 1894, junior college 1921, college 1939; arts and sciences, education.

Pacific Ocean, largest of the oceans P-1–19, *maps* P-16–17, N-245, S-256, A-411, A-478, *pictures* P-1–3, 9–14, *color pictures* P-5–8. *See also in Index* Ocean, *table*
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Pacific oyster O-436

Pacific Railway. *See in Index* Canadian Pacific Railway

Pacific Ranges, or Coast Ranges, U.S., *map* U-250. *See also in Index* Coast Ranges

Pacific red cedar. *See in Index* Western red cedar

Pacific region, in U.S. *See in Index* North Pacific region; South Pacific region

Pacific salmon S-28, 29, F-115: trolling boat, *picture* F-113. *See also in Index* Salmon
migration, *map* M-241, *pictures* S-28, M-244

Pacific Scandal, in Canadian history C-100

Pacific silver fir. *See in Index* Silver fir

Pacific States, name used by U. S government for geographic division including states of Washington, Oregon, California.

Pacific time T-136, *map* U-252

Pacific Union College, at Angwin, Calif.; Seventh-day Adventist; chartered as Healdsburg College 1882; present name from 1909; arts and sciences; graduate studies.

PANICS AND DEPRESSIONS IN THE UNITED STATES

Economists make a distinction between panics, crises, and depressions. An industrial or financial crisis reaches its peak in a panic, when commodity and security prices fall sharply. The panic is usually followed by a period of depressed activity and readjustment, until confidence is restored and business again reaches a normal level. Almost invariably a crisis is preceded by a period of abnormally high activity, when prosperity is accompanied by inflated prices of commodities, of securities, and of real estate. The earlier crises or panics were mostly the result of European difficulties, and were not so severe or widespread in the United States. In 1793, the unexpected declaration of war between France and England was followed by troubles for American shipping, and caused a period of decline. Again, after 1802, the peace of Amiens was followed by maritime prosperity, to be ended abruptly by the Embargo and Non-Importation troubles in 1807 and 1808. The War of 1812 brought industry in the United States to a low point, from which it recovered rapidly, for several years, only to suffer a slump in the years 1819–22. The first major panic and crisis came in 1837.

1837. The era of internal improvements, of building canals, railroads, and roads, involved excessive extension of credits by banks and unwarranted borrowings by the state governments. A crisis was precipitated by the refusal of Congress to renew the charter of the Bank of the United States. This was the signal for an outburst of fear; many banks closed, business firms failed, and industry was paralyzed. Some of the states repudiated bonds issued for the payment of improvements, and depression continued for seven or eight years.

1857. After the Mexican War and the discovery of gold in California, the United States went through a period of deflation, during which interest rates declined and speculation increased. Railroads were built on a scale far beyond the country's immediate need. Then came panic. Several large life insurance companies failed, and depression continued, with a short interruption during the war years, until the new industrial development in the late 60's and early 70's.

1869. The money panic of this year reached its climax on September 24, "Black Friday," in the attempt of Jay Gould and Jim Fisk to corner the gold supply of the United States. At the peak, $1.63 in greenbacks was required to buy $1.00 in gold. The effects were limited to the financial centers, and there were no general disturbances throughout the country. At the same time, however, European markets were disrupted by the opening of the Suez Canal.

1873. A new period of inflation began about 1868. In the next five years over 30,000 miles of railroad were built. Joint stockcompanies were taking the place of old-fashioned partnerships. Industrial expansion was going on at a feverish rate. In Europe during the same years, following the Franco-Prussian War, there was great expansion in Germany and Austria, culminating in the "Vienna crash" of 1873. The break in the United States was begun by the failure of Jay Cooke & Company. General business and financial deflation was followed by the worst depression the United States had yet seen. This low period continued for about six years, until a new burst of activity which followed the resumption of specie payments in 1879.

1884. The panic of 1884 was a money and bankers' panic, precipitated by the failure (May 8) of the firm of Grant and Ward, of which Gen. U. S. Grant was a partner. The resulting depression was not severe and lasted only about two years.

1890. This was another bankers' panic, brought on by the failure of Baring Brothers, the great London firm of international bankers, with very close connections in New York and Boston. Baring Brothers failed November 10. The Bank of England and a strong private banking firm came to their rescue, and the effects of the crisis were slight.

1893. The panic or crisis of 1893 was caused by agricultural depression, by unsound railroad financing, and perhaps even more by uncertainty about the financial stability of the United States. The operation of the Sherman Silver Purchase Act was obviously endangering the gold reserves of the treasury. Many banks failed, 20,000 miles of railroad went into receivership, and the following economic depression was prolonged and severe, including grave labor disturbances in the East and Middle West. One of the consequences of this crisis was the formal adoption of the gold standard by the United States (March 4, 1900).

1901. Stock market panic, culminating May 9, as the result of a struggle between the Harriman-Kuhn-Loeb interests and the Morgan-James J. Hill group for the control of the Northern Pacific Railroad. The stock of this railroad was cornered, and the collapse of the corner was followed by a general collapse in security prices.

1907. The panic of this year was a money panic, sometimes called the Knickerbocker Trust panic, because the failure of that company (October 22) precipitated it. The financial difficulties of that company and of others which failed were caused chiefly by the efforts of the Heinze group to combine control of various banks, copper companies, and other interests.

1914. The outbreak of World War I was followed immediately by panic in all the financial centers of the world. Stock and grain exchanges were closed in New York, Chicago, and other cities. Clearinghouse certificates were used between banks in settling balances, and the treasury immediately made available, under the Aldrich-Vreeland Act of 1908, an ample supply of emergency bank notes, thus enabling the banks to meet the demand for cash while at the same time husbanding their gold reserves. Unlike most panics, this one was followed by a sharp expansion in business activity, made necessary by the Allied demand for supplies and munitions. This activity was greatly increased when the United States entered the war.

1921. The year 1921 marks a new crisis and the beginning of the "primary postwar depression." The end of the war found the United States with overexpanded facilities for production, and with an accumulation of food and material of all kinds which Europe could not use. One result of the situation was a sharp break in wholesale commodity prices, notably sugar. Readjustment and depression on a minor scale continued for several years until the turn which came with the "Coolidge prosperity" and reached its peak in the "bull market" of 1929.

1929. The years of the Coolidge administration witnessed expansion and inflation on a scale hitherto unknown in any country in the world. Inflation in wages, real-estate values, and stock prices seemed to bring prosperity to everyone. While financial activity continued at an unprecedented rate through the summer of 1929, industrial activity was already slowing down. The collapse of the speculative mania in the stock market was slowly followed by a realization that in the United States as well as in other parts of the world many grave economic and financial problems had not been faced. These were now to cause the most serious disarrangement of economic structure which the world had yet known. Agricultural depression, the result of falling prices for farm products and for land, cost thousands of farmers their homes through foreclosure. Unemployment and bank failures were greater than ever before in American history. The domestic factors were complicated by foreign affairs, such as reparations and the questions of inter-Allied debts.

pest, Hungary; taught at Paris; came to New York City 1941.

Philippe Egalité. *See in Index* Orléans, Louis Philippe, duke of

Philippeville, Algeria, seaport in n.e.; port for Constantine; pop. 40,647: *maps* A-167, A-46

Philippi (*fĭ-lĭp'ī*), ancient city of n.e. Macedonia; named from Philip II of Macedon; Epistle to Philippians sent to city's Christians: *map* M-7
battle of (42 B.C.) A-472*a*

Philip'pians, Epistle to, book of the New Testament; letter from Paul to Christians at Philippi reassuring them of his prospects of release and appealing for unity in their church; probably written at Rome shortly before his release A.D. 63.

'Philip'pics'
Cicero C-307
Demosthenes D-67

Philippine (*fĭl'ĭ-pēn*) **Islands (Republic of the Philippines),** archipelago between China Sea and Pacific Ocean; 115,600 sq. mi.; pop. 19,234,182; official capital Quezon City: P-192–202, *maps* P-195, A-407, P-16, *pictures* P-192–3, 196–202
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Philippines, University of the P-199, *picture* P-198

Philippopolis, Bulgaria. *See in Index* Plovdiv

Philipse, Frederick (1626–1702), Dutch merchant in colonial New York, born Friesland, Netherlands; went to New Amsterdam 1647
Philipse Manor Y-341

Philis'tia, ancient country of the Philistines in s.w. Palestine P-44

Philis'tines, tribe of ancient Canaan P-202
David defeats D-21

Phillip, Arthur (1738–1814), English naval officer; first governor of New South Wales; founded city of Sydney: A-491

Phillips, Coles (Clarence) (1880–1927), artist, born Springfield, Ohio; prominent for magazine covers and illustrations depicting beautiful young women; pioneer advertising illustrator.

Phillips, Stephen (1868–1915), English poet and dramatist; dramas in blank verse include 'Paolo and Francesca', 'Herod: a Tragedy', and 'Ulysses'; 'Marpessa' is one of best-known poems.

Phillips, Wendell (1811–84), abolitionist orator, born Boston, Mass.; educated as lawyer; eloquent and radical in support of antislavery cause; supported women's rights and many other reforms; introduced direct colloquial style of American oratory
abolitionist movement C-331: meeting on Boston Common, *picture* U-381
women's rights W-184

Phillipsburg, N.J., town on Delaware River 50 mi. n. of Trenton; pop. 18,919; r.r. shops, iron and steel products; silk mills: *map* N-164

Phillips Exeter Academy, boys' school at Exeter, N. H.; founded 1782.

Phillips Gallery, Washington, D.C., founded 1918 as a museum of modern art and its sources; collection includes paintings by contemporary and earlier American artists and by European artists of four centuries, and is housed in the former home of **Duncan Phillips** (art critic, born 1886), founder and director of the gallery
'Maine Island', by John Marin, *color picture* P-37

Phillips University, at Enid, Okla.; Disciples of Christ; founded 1907; arts and sciences, Bible, business administration, fine arts, home economics; graduate seminary.

Phillpotts (*fĭl'pŏts*), **Eden** (born 1862), English novelist, born in India, the son of an army officer; educated in England; tried acting, and was in business for 10 years; wrote poems, plays, and mystery and historical novels but is best known for stories of Devonshire country and people ('Children of the Mist'; 'Sons of the Morning'; 'The Jury'; 'Widecombe Fair'; 'One Hundred Sonnets').

Philo, or Philo Judaeus (*fī'lō ǧụ-dē'ŭs*) (20 B.C.–A.D. 40?), Hellenistic-Jewish philosopher; lived in Alexandria; sought to harmonize Greek philosophy and teachings of Moses.

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Philomel (*fĭl'ō-mĕl*), or **Philome'la,** poetic name for nightingale. Philomela, in Greek mythology, was sister of Procne (*prŏk'nē*), wife of Tereus, king of Thrace; in revenge for their wrongs the sisters killed Itys, Tereus' son, and served him as food to his father; the gods punished them by turning Procne into a swallow and Philomela into a nightingale.

Philosopher's stone, mythical substance with miraculous powers sought by alchemists C-221, A-145

Philosophical Society. *See in Index* American Philosophical Society

Philosophy (*fĭ-lŏs'ō-fĭ*) P-203–4
American philosophers P-204
English philosophers P-204
ethics E-400
French philosophers P-204
German philosophers G-84–5, P-204
Greek philosophers G-202, G-211–12, P-204
psychology once a branch of P-426
Roman philosophers P-204
Scholastic P-204, W-211

Phineus (*fĭn-yŭs'* or *fĭn'ē-ŭs*), in Greek mythology, Thracian king; tormented by Harpies H-271

Phips, Sir William (1651–95), American sea captain, royal governor of Massachusetts (1692–95); an illiterate shepherd and ship carpenter in his youth, he rose to baronetcy by raising a Spanish treasure ship sunk off Bahama Islands (1687); led successful surprise attack on Acadia, but was defeated by Frontenac at Quebec (1690). Appointed governor of Massachusetts through influence of Cotton Mather, he suppressed witchcraft trials and built fort at Pemaquid, but otherwise so incompetent that he was recalled; died in England before trial was held.

Phiva, Greece. *See in Index* Thevai

Phlegethon (*flĕǧ'ē-thŏn*), in Greek mythology, a river of fire in the lower world.

Phloem (*flō'ĕm*), inner bark of tree P-292, *picture* T-179

Phlogiston (*flō-ǧĭs'tŏn*), "fire substance" supposed in 17th and 18th centuries to exist in combustible bodies and to be lost on combustion; theory refuted by Lavoisier: F-73, L-139

Phlox (*flŏks*), a garden flower P-204
how to plant, *table* G-17
pollen grain, *pictures* F-186, P-204
sweet William P-204, *color picture* F-171

Phlox family, or Polemoniaceae (*pŏl-ē-mō-nĭ-ā'sē-ē*), a family of plants and small trees including the phloxes, cobaeas, gilias, birdseyes, skunkweed, and Jacobs-ladder.

Phnom Penh, Cambodia, Indo-China. *See in Index* Pnom-Penh

Phobia, an abnormal fear
psychoanalysis in treatment P-424*b*–5

Phobos (*fō'bŏs*), satellite of Mars P-284

Phocion (*fō'shĭ-ŏn*) (402?–317 B.C.), Athenian general, opponent of Demosthenes and the anti-Macedonians, virtual ruler of Athens for a time after Chaeronea; finally forced to drink hemlock for alleged treason.

Phocis (*fō'sĭs*), ancient district in central Greece; chief mountain, Parnassus; took part in Sacred War (357–346 B.C.) and was conquered by Philip of Macedon; contained shrine of Delphic Oracle: *map* G-197

Phoebe (*fē'bē*), in Greek mythology, name given to Artemis (Diana) as a moon goddess; also, poetically, to the moon; feminine form of Phoebus.

Phoebe, a bird of the flycatcher family F-190, *picture* F-190

Phoebe, satellite of Saturn P-284

Piacenza (*pē-yä-chĕnt'sä*). fortified town in n.-central Italy on Po River; pop. 49,527; founded by Romans as Placentia 218 B.C.; a leading town of Lombard League in Middle Ages: *map* E-425

Pia mater (*pī'a mā'tĕr*), of brain B-280

Piankashaw, Indian tribe of Algonquian stock, once branch of Miami; controlled lower Wabash Valley.

Piano (*pĭ-ăn'ō*, also *pĭ-ä'nō*), or **pianoforte** (*pĭ-ăn-ō-fōr'tē* or *pĭ-ăn'ō-fōrt*) P-247–51, M-470, *pictures* P-247–51, M-471
- concert pitch M-468*b*
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- musical development promoted by P-250–1, B-10
- notes and octaves P-249, *diagram* M-468*b*
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- pitches of notes S-238, 240
- player piano P-250
- range of notes S-238, P-249
- strings P-248–50, S-238
- tuning M-469

Piano, pianissimo, and pianississimo. *See in Index* Music, *table* of musical terms and forms

Piano accordion M-472

Pianoforte. *See in Index* Piano

Piasa bird, a legendary man-eating monster which, according to the Illini Indians, would swoop down and carry off hunters. A picture of the bird on a cliff overlooking the Mississippi was seen by Marquette and Joliet on their trip down the river in 1673. This picture, north of Alton, Ill., was destroyed in quarrying operations in 1870. A reproduction, painted in 1924, was blasted away in 1950 for the McAdams Memorial Highway. The present picture (30 by 17 ft.), painted in 1952 on a high cliff, overlooks both highway and river.

Piassava (*pē-a-sä'va*), fiber from a palm grown in Brazil (*Attalea funifera*) and Africa (*Raphia vinafera*); used in making ropes, sails, mats, and brushes; African piassava inferior to Brazilian; other fibers also known as piassava
- Bahia piassava, *table* F-63

Piaster (*pĭ-ăs'tĕr*), a coin formerly worth about 47 cents in French Indo-China, about 5 cents in Turkey and Egypt, 8 cents in Syria; later monetary unit of Turkey, historical value 4½ cents.

Piatigorsky (*pē-ăt-ē-gôr'skē*), **Gregor** (born 1903), American cellist, born Russia; appeared in concerts in Russia at age of 9; toured throughout Europe, and from 1929 in America; head of violoncello dept., Curtis Institute, Philadelphia, from 1942.

Piauí, formerly **Piauhy** (*pyou-ē'*), Brazil, state, touching n. seacoast; 97,175 sq. mi.; pop. 1,045,696; cap. Teresina: B-291

Piave (*pē-yä'vā*), river of n.e. Italy; rises in Carnic Alps and joins Adriatic Sea 20 mi. n.e. of Venice; length 130 mi.
- in World War I W-228, 230–1

Piazzi (*pyät'sē*), **Giuseppe** (1746–1826), Italian astronomer, discoverer of first asteroid (Ceres) A-426

Picabia (*pē-kä'byä*), **Francis** (1879–1953), French artist, born Paris; worked first as impressionist, later as cubist; then became one of leaders in surrealism.

Pic'ador, in bull fighting, a horseman with a wooden rod tipped with steel, called a "pica," with which he torments the bull.

Picard (*pē-kär'*), **Jean** (1620–82), French astronomer
- measures a degree of latitude, *diagram* E-193

Picardy (*pĭk'ăr-dĭ*), old province of n. France; contained towns of Amiens (capital) and Boulogne, and battlefields of Agincourt, Crécy, Saint-Quentin: *map* F-270
- World War I, battle 1918 S-236

Picaresque (*pĭk-a-rĕsk'*) **novel** N-311

Picasso (*pē-kä'sō*), **Pablo** (born 1881), Spanish painter, born Malaga, Spain; lived in Paris; one of leaders of postimpressionist school; pioneer in cubism; reverted to naturalism, later did abstract painting: S-82, P-34*b*, D-140*c*
- 'Head of a Woman' D-140*c*, *picture* D-140*c*
- 'Three Musicians' P-34*b*, *color picture* P-34

Pi'ca type T-228

Pic'cadilly Circus, London, England L-305, *map* L-300, *picture* L-306

Piccard (*pē-kär'*), **Auguste** (born 1884), Swiss physicist, born Basel, Switzerland; professor University of Brussels, Belgium, after 1922; noted for balloon ascents into the stratosphere and for descents into the ocean depths; with son, **Jacques Piccard** (born 1922?), set new depth record Sept. 1953: B-36 O-328, E-455

Piccard, Jean Félix (born 1884), American chemical and aeronautical engineer, born Basel, Switzerland, twin brother of Auguste; became U. S. citizen 1931; most noted for researches in explosives.

Pic'colo, a small flute W-189, *picture* M-471
- range of, *diagram* M-468*b*

Piccolomini (*pēk-kō-lō'mē-nē*), **Aeneas Sylvius** (Pius II) (1405–64), pope P-276

Piccolomini, Ottavio, Prince (1599–1656), duke of Amalfi, born Florence; general in Thirty Years' War; in German Imperial and Spanish service; attained rank of field marshal; while in Wallenstein's army was instrumental in effecting this general's downfall by joining in a conspiracy against him; made a prince 1650.

Picea (*pĭs'ē-a*), the spruce genus of trees S-358

Pichincha (*pē-chēn'chä*), volcano on w. slope of Andes near Quito, Ecuador (highest peak 15,918 ft.); battle between revolutionary patriots and Spaniards which freed Ecuador fought on slopes 1822.

Pichola (*pē-chō'lä*), lake in native state of Udaipur, India
- island palaces I-65

Picidae (*pĭs'ĭ-dē*), the woodpecker family W-189

Piciformes (*pĭs-ĭ-fôr'mēz*), an order of sharp-billed birds, comprising woodpeckers, flickers, sapsuckers, toucans, barbets.

Pick, Lewis Andrew (born 1890), U.S. Army officer and civil engineer, born Brookneal, Va.; with W. Glenn Sloan, author of Pick-Sloan plan for Missouri basin; in World War II won Distinguished Service Medal for building Stilwell Road (called "Pick's Pike"); retired as lieutenant general 1953
- Pick-Sloan plan M-325*b*

Pickens, Andrew (1739–1817), soldier, born Paxton, Pa.; brigadier general of South Carolina troops in Revolutionary War; distinguished himself at Cowpens and Eutaw Springs; member of South Carolina legislature 1783–94 and 1801–12; in Congress 1793–95.

Pickens, Francis Wilkinson (1805–69), American statesman, advocate of states' rights; as governor of South Carolina (1860–62) demanded surrender of Fort Sumter and ordered erection of artillery batteries which caused its surrender.

Pick'erel, fish P-256, F-115

Pickerelweed, or **pondweed** W-67, *color picture* P-286

Pick'ering, Edward Charles (1846–1919), astronomer, born Boston, Mass.; great-grandson of Timothy; studied light and spectra; in 1891 set up station at Arequipa, Peru, to study stars.

Pickering, Timothy (1745–1829), statesman, born Salem, Mass.; member of Essex Junto and Hartford Convention; as secretary of war (1795) established West Point Military Academy.

Pickering, William Henry (1858–1938), astronomer, brother of Edward C., discovered Phoebe and Themis, 9th and 10th satellites of Saturn; work in planetary photography and photometry; helped Edward set up observation station at Arequipa, Peru (1891).

Pickersgill, Mary Young, flagmaker; in 1814 made the flag which inspired Francis Scott Key to write the 'Star Spangled Banner'; made banners and pennants for the clipper ships of Baltimore.

Picket, in strike L-70*c*, *picture* L-70*a*

Picketing, the practice of trade unions of placing watchers near the entrance of factories or other places of employment to dissuade nonunion workers from accepting employment during a strike.

Pickett, George Edward (1825–75), Confederate general, born Richmond, Va.
- defeated at Five Forks S-147
- Gettysburg G-106, *map* G-105, *picture* C-330
- San Juan Island W-48

Pickford, Mary, *stage name of* Gladys Smith (born 1893), American *motion-picture actress, born* Toronto, Canada; made stage debut at 5; later appeared in David Belasco productions; turned to motion-picture work; married Douglas Fairbanks 1920, divorced 1935; married Charles (Buddy) Rogers 1937 ('Tess of the Storm Country'; 'Cinderella'; 'Daddy Long Legs'; 'Coquette', for which she won Academy award in 1929): *picture* M-433

Pickles, made from cucumbers C-529

Pick-Sloan plan, government plan for harnessing the Missouri River and developing the land and water resources of the valley M-325*b*–6, *map* M-325*a*–*b*

Pickthall, Marjorie Lowrey Christie (1883–1922), Canadian poet and novelist, born in England; best known for poetry ('Drift of Pinions'; 'Wood Carver's Wife'; 'Angel's Shoes', short stories).

'Pickwick Papers', novel by Charles Dickens D-83, 84*a*, *b*, 85, *picture* D-84

Picnic
- family picnic, *picture* F-18*a*

Pico (*pē'kū*), island and mountain of Azores A-542

Pico, mountain opposite Sugar Loaf on harbor of Rio de Janeiro.

Pic'ric acid, a yellow, crystalline, organic acid, used in manufacture of explosives E-458

Pictograph, in ancient times W-310, *picture* W-310*a*

Pictograph (Isotype), visual-educa-

Key: cape, ăt, far, fast, what, fall, me, yet, fērn there, ice, bit, row, won, for, nŏt, do, cure, bŭt, rude, full, bûrn, out,

POPES OF THE ROMAN CATHOLIC CHURCH

NOTE: The dates are those given by the 'Catholic Encyclopedia'. Names of doubtful popes and antipopes are in brackets, thus [ ]. Names followed by an asterisk (*) indicate popes canonized as saints by the Roman Catholic church.

died 67?	Peter*
67-79?	Linus*
79-90?	Anacletus*
90-99?	Clement I*
99-107?	Evaristus*
107-116?	Alexander I*
116-125?	Sixtus I (Xystus)*
125-136?	Telesphorus*
136-140?	Hyginus*
140-154?	Pius I*
154-165?	Anicetus*
165-174	Soter*
174-189	Eleutherius*
189-198	Victor I*
198-217	Zephyrinus*
217-222	Calixtus I*
222-230	Urban I*
230-235	Pontianus*
235-236	Anterus*
236-250	Fabian*
251-253	Cornelius*
[251-258?	Novatianus]
253-254	Lucius I*
254-257	Stephen I*
257-258	Sixtus II*
259-268	Dionysius*
269-274	Felix I*
275-283	Eutychianus*
283-296	Caius*
296-304	Marcellinus*
308-309	Marcellus I*
309 or [310]	Eusebius*
311-314	Melchiades*
314-335	Sylvester I*
336	Marcus*
337-352	Julius I*
352-366	Liberius
[355-365	Felix II]
366-384	Damasus I*
384-398	Siricius*
398-401	Anastasius I*
402-417	Innocent I*
417-418	Zosimus*
418-422	Boniface I*
422-432	Celestine I*
432-440	Sixtus III*
440-461	Leo I*
461-468	Hilarius*
468-483	Simplicius*
483-492	Felix II (III)*
492-496	Gelasius I*
496-498	Anastasius II
498-514	Symmachus*
514-523	Hormisdas*
523-526	John I*
526-530	Felix III (IV)*
530-532	Boniface II
533-535	John II
535-536	Agapetus I*
536-538?	Silverius*
538?-555	Vigilius
556-561	Pelagius I
561-574	John III
575-579	Benedict I
579-590	Pelagius II
590-604	Gregory I, the Great*
604-606?	Sabinianus
607	Boniface III
608-615	Boniface IV*
615-618	Adeodatus I*
619-625	Boniface V
625-638	Honorius I

638-640	Severinus
640-642	John IV
642-649	Theodore I
649-655	Martin I*
654-657	Eugenius I*
657-672	Vitalianus*
672-676	Adeodatus II
676-678	Donus
678-681	Agathon*
682-683	Leo II*
684-685	Benedict II*
685-686	John V
686-687	Conon
687-701	Sergius I*
701-705	John VI
705-707	John VII
708	Sisinnius
708-715	Constantine
715-731	Gregory II*
731-741	Gregory III*
741-752	Zacharias*
[752	Stephen]
752-757	Stephen II
757-767	Paul I*
[767-768	Constantine]
768-772	Stephen III
772-795	Adrian I
795-816	Leo III*
816-817	Stephen IV
817-824	Paschal I*
824-827	Eugenius II
827	Valentine
827-844	Gregory IV
844-847	Sergius II
847-855	Leo IV*
[855	Anastasius]
855-858	Benedict III
858-867	Nicholas I*
867-872	Adrian II
872-882	John VIII
882-884	Marinus I
884-885	Adrian III*
885-891	Stephen V
891-896	Formosus
896	Boniface VI
896-897	Stephen VI
897	Romanus
897	Theodore II
898-900	John IX
900-903	Benedict IV
903	Leo V
903-904	Christopher
904-911	Sergius III
911-913	Anastasius III
913-914	Lando
914-928	John X
928	Leo VI
928-931	Stephen VII
931-936	John XI
936-939	Leo VII
939-942	Stephen VIII
942-946	Marinus II
946-955	Agapetus II
955-964	John XII
[963-965	Leo VIII]
964-965	Benedict V
965-972	John XIII
973-974	Benedict VI
[974	Boniface VII]
974-983	Benedict VII
983-984	John XIV
984-985	Boniface VII
985-996	John XV

996-999	Gregory V
[997-998	John XVI]
999-1003	Sylvester II
1003	John XVII
1003-09	John XVIII
1009-12	Sergius IV
1012-24	Benedict VIII
1024-32	John XIX
1032-45	Benedict IX
[1045	Sylvester III]
1045-46	Gregory VI
1046-47	Clement II
[1047-48	Benedict IX]
1048	Damasus II
1049-54	Leo IX*
1055-57	Victor II
1057-58	Stephen IX
[1058-59	Benedict X]
1059-61	Nicholas II
1061-73	Alexander II
[1061-64	Honorius II]
1073-85	Gregory VII*
[1084-1100	Clement III]
1087	Victor III
1088-99	Urban II
1099-1118	Paschal II
[1105-11	Sylvester IV]
1118-19	Gelasius II
[1118-21	Gregory VIII]
1119-24	Calixtus II
1124-30	Honorius II
[1124	Celestine II]
1130-43	Innocent II
[1130-38	Anacletus II]
[1138	Victor IV]
1143-44	Celestine II
1144-45	Lucius II
1145-53	Eugenius III
1153-54	Anastasius IV
1154-59	Adrian IV
1159-81	Alexander III
[1159-64	Victor IV]
[1164-68	Paschal III]
[1168-78	Calixtus III]
[1179-80	Innocent III]
1181-85	Lucius III
1185-87	Urban III
1187	Gregory VIII
1187-91	Clement III
1191-98	Celestine III
1198-1216	Innocent III
1216-27	Honorius III
1227-41	Gregory IX
1241	Celestine IV
1243-1254	Innocent IV
1254-61	Alexander IV
1261-64	Urban IV
1265-68	Clement IV
1271-76	Gregory X
1276	Innocent V
1276	Adrian V
1276-77	John XXI
1277-80	Nicholas III
1281-85	Martin IV
1285-87	Honorius IV
1288-92	Nicholas IV
1294	Celestine V*
1294-1303	Boniface VIII
1303-04	Benedict XI
1305-14	Clement V
1316-34	John XXII
[1328-30	Nicholas V]

1334-42	Benedict XII
1342-52	Clement VI
1352-62	Innocent VI
1362-70	Urban V
1370-78	Gregory XI
1378-89	Urban VI
[1378-94	Clement VII]
1389-1404	Boniface IX
[1394-1423	Benedict XIII]
1404-06	Innocent VII
1406-15	Gregory XII
1409-10	Alexander V
1410-15	John XXIII
1417-31	Martin V
[1424	Benedict XIV]
[1424-29	Clement VIII]
1431-47	Eugenius IV
[1439-49	Felix V]
1447-55	Nicholas V
1455-58	Calixtus III
1458-64	Pius II
1464-71	Paul II
1471-84	Sixtus IV
1484-92	Innocent VIII
1492-1503	Alexander VI
1503	Pius III
1503-13	Julius II
1513-21	Leo X
1522-23	Adrian VI
1523-34	Clement VII
1534-49	Paul III
1550-55	Julius III
1555	Marcellus II
1555-59	Paul IV
1559-65	Pius IV
1566-72	Pius V*
1572-85	Gregory XIII
1585-90	Sixtus V
1590	Urban VII
1590-91	Gregory XIV
1591	Innocent IX
1592-1605	Clement VIII
1605	Leo XI
1605-21	Paul V
1621-23	Gregory XV
1623-44	Urban VIII
1644-55	Innocent X
1655-67	Alexander VII
1667-69	Clement IX
1670-76	Clement X
1676-89	Innocent XI
1689-91	Alexander VIII
1691-1700	Innocent XII
1700-21	Clement XI
1721-24	Innocent XIII
1724-30	Benedict XIII
1730-40	Clement XII
1740-58	Benedict XIV
1758-69	Clement XIII
1769-74	Clement XIV
1775-99	Pius VI
1800-23	Pius VII
1823-29	Leo XII
1829-30	Pius VIII
1831-46	Gregory XVI
1846-78	Pius IX
1878-1903	Leo XIII
1903-14	Pius X*
1914-22	Benedict XV
1922-39	Pius XI
1939-	Pius XII

Huron; pop. 35,725; extensive Canadian trade; connected with Sarnia, Ontario, Canada, by railroad tunnel, ferry service, and Blue Water International Bridge; salt, automobile parts, wire, paper; railroad shops; summer resort: *maps* M-227, U-253

Portia (*pôr'shĭ-ạ*), heroine of Shakespeare's 'Merchant of Venice' M-173

Portico style, *in architecture* A-320, *color picture* U-276

Portinari (*pŏr-tē-nä'rē*), **Candido** (born 1903), Brazilian painter, born São Paulo, Brazil, son of an Italian coffee worker; uses ultramodern as well as classical styles; murals, portraits, and pictures of Brazilian life, especially life among Negroes
- 'Festival, St. John's Eve' P-37*a*, *color picture* P-37*a*

Port Jervis, N. Y., a railroad center and summer resort on Delaware River 60 mi. n.w. of New York City, at junction of New York, New Jersey, and Pennsylvania boundaries; pop. 9372; railroad shops; silverware plate, gloves, glass, silk: *map, inset* N-204

Portland, Me., largest city and chief seaport in state on Casco Bay 50 mi. s.w. of Augusta; pop. 77,634; food and fish processing; paper, furniture, and other wood products; textile products, tools, marine hardware, machinery; Westbrook Junior College and Portland Junior College; burned by British 1775: M-55, *maps* M-53, U-253, *picture* M-56

Portland, Ore., largest city of state; pop. 373,628: P-376–7, *color picture* U-309, *maps* U-252, *inset* O-416
- St. Johns Bridge and Willamette River Bridge. *See in Index* Bridge, *table*

Portland, Isle of, peninsula on coast of Dorsetshire, England; noted for building stone: *map* B-325
- portland cement named for C-167

Portland, University of, at Portland, Ore.; Roman Catholic; founded 1901; arts, business, engineering, music, nursing, science; graduate studies.

Portland cement C-165–6, 167

Portland vase, beautiful dark blue glass urn decorated with white figures in relief; found in tomb near Rome; broken by a madman in 1845 but skillfully repaired; long exhibited in British Museum: *picture* E-446

Port Louis, capital of Mauritius; pop. 69,693.

Port Mahon, Balearic Islands. *See in Index* Mahón

Port Moresby (*mōrz'bĭ*), New Guinea, seaport on s.e. coast; capital of Territory of New Guinea and of Territory of Papua; pop. 17,546: N-143, *maps* E-203, P-16

Port Natal, Natal, Union of South Africa. *See in Index* Durban

Port Nelson, Manitoba, Canada, town at mouth of Nelson River on Hudson Bay: *maps* C-68, 81

Port Newark Terminal N-135

Porto (*pôr'tō*), also **Oporto,** Portugal, 2d city, seaport and commercial center on Douro River, 2 mi. from sea; pop. 281,406; textiles, port wine: P-378, 379, *maps* E-416, 425, S-312

Pôrto Alegre (*ä-lä'grä*), port and capital of state of Rio Grande do Sul, Brazil, near n. extremity of Lake Patos in agricultural and grazing country; pop. 375,049; German colony handled most of commerce before World War I: B-292, *maps* B-288, S-253

Portobello, also **Porto Bello,** port on Atlantic coast of Panama 20 mi. n.e. of Colón; pop. 1000; early shipping point: P-52, *maps* P-62, C-172
- pack-train terminus P-53, *picture* C-177

Port of call, port at which vessels are accustomed to stop for repairs, supplies, or similar requirements.

Port of entry, any point, whether on the frontier or not, designated by the customs authorities as a place where merchandise or persons may fulfill the legal requirements for entering or departing from a country. Need not be a nautical port.

Port of Spain, capital of Trinidad; pop. 92,793: T-190, *maps* S-252, W-96*a*

Porto Grande (*pōr'tō grän'dä*), port and commercial center of Cape Verde Islands C-119, *map, inset* A-47

Portolá (*pôr-tō-lä'*), **Gaspar de,** 18th-century Spanish explorer; governor of California (1769–71); discovered San Francisco Bay (1769) while searching for Monterey Bay after long, hunger-tortured march from Lower California; founded San Diego and Monterey missions and presidios: C-46

Portolano, navigator's chart N-79

Port Orford cedar, evergreen tree (*Chamaecyparis lawsoniana*) of pine family, sometimes called Lawson's cypress, Oregon cedar, and white cedar; many varieties used as ornamental trees. Grows 125 ft. to 200 ft., lives to 600 years; pyramid-shaped, with sharply drooping branches. Wood pale brown, of moderate lightness; Oregon cedarwood oil distilled from wood, used in insecticides: *table* W-186*b*

Porto-Riche (*pôr-tō-rēsh'*), **Georges de** (1849–1930), French dramatist, born Bordeaux; his plays are studies of the emotions of men and women in love ('La Chance de Françoise'; 'Le Passé'; 'Le Vieil Homme'; 'Le Marchand d'Estampes'; 'L'Infidèle'; 'Amoureuse').

Porto Rico, island of West Indies. *See in Index* Puerto Rico

Porto San'to, a rugged island of Madeira group, 26 mi. n.e. of Madeira; about 17 sq. mi.; pop. 3017. *map* A-46

Port Republic, Va., village on Shenandoah River 90 mi. n.w. of Richmond; here Confederates under "Stonewall" Jackson defeated Federals under General Shields June 9, 1862: *maps* V-486, C-335

Port Royal, Nova Scotia, Canada, former name of Annapolis Royal N-309
- founded C-95*a*, N-308–9
- national historic park N-39, *picture* N-307

Port Royal, S. C., first settlement in South Carolina; pop. 793: S-284, *map* S-291

Ports. *See in Index* Harbors and ports

Port Said (*sa-ēd'*), Egypt, at n. end of Suez Canal; pop. 178,432; founded as coaling station 1859; exports cotton; attempt of Turks during World War I to capture city and wreck canal failed: S-442*a*, *maps* E-271, A-46, S-442*b*

Portsea, England, naval station P-377

Portsmouth (*pôrts'mŭth*), England, great English naval station and arsenal, 74 mi. s.w. of London; pop. 233,464: P-377, *map* B-325

Portsmouth, N. H., seaport city on Piscataqua River 3 mi. from Atlantic: pop. 18,830; shoes, fiber board; coal-distributing point: N-144, *maps* N-151, U-253. *See also in Index* Portsmouth Navy Yard.

Portsmouth, Ohio, city on Ohio and Scioto rivers, and at s. end of Ohio Canal; pop. 36,798; agricultural and mining region; steel and iron products, shoes, brick; railroad shops: *maps* O-357, U-253
- atomic plant nearby O-361

Portsmouth, Va., city in s.e., a port of Hampton Roads, on Elizabeth River opposite Norfolk; pop. 80,039; wood products, food processing, metal products, chemicals. First settled 1664, established as town 1752, chartered as city 1858; landing place and base for British invading expeditions during Revolutionary War. Norfolk Naval Shipyard (first called Gosport Navy Yard), owned first by British, later by state; purchased by U.S. government 1801; *Chesapeake,* first ship built by federal government, built here 1799; *Merrimac* prepared here for famous fight with *Monitor.* City held for a year by Confederates during Civil War. U.S. Naval Hospital opened 1830: N-242*b*, C-224, *maps* V-487, U-253

Portsmouth, Treaty of (1905) R-296

Portsmouth Navy Yard, U. S. Naval Base near Portsmouth, N. H.; on islands on Maine side of Piscataqua River; builds and repairs submarines; established about 1800.

Port Stanley, Falkland Islands. *See in Index* Stanley

Port Stanley, Ontario, Canada, village and harbor on Lake Erie, 23 mi. s. of London; pop. 1491.

Por'tugal, republic of s.w. Europe; 34,60[illegible] sq. mi.; pop. 8,510,240; cap. Lisbon: P-378–81, *maps* S-312, E-416, 42*b*, *pictures* P-378–81, *Reference-Outline* S-323–4
- Azores A-542
- bibliography S-324
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  - Lisbon L-266
- climate P-378–9
- clothing, *pictures* P-379: explorers, 16th century, *picture* M-32, *color picture* M-31
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  - Cape of Good Hope discovered by Bartholomew Diaz C-118, D-83
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  - Cape Verde Islands discovered C-119
  - Vasco da Gama's explorations G-7–8, *picture* G-8: Mozambique M-442
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  - Far East explorations: Ceylon C-180; East Indies E-201, 208; Japan J-319; Malay Peninsula M-60
  - Lisbon earthquake (1755) E-196, L-266
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  - revolution of 1910 L-266, P-381
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- Madeira Islands M-22
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THE PRESIDENTS OF THE UNITED STATES

	Name	Term	Age	Party	Elected from	Occupation
1.	George Washington	1789–1797	57	Federalist	Virginia	Planter
2.	John Adams	1797–1801	61	Federalist	Massachusetts	Lawyer
3.	Thomas Jefferson	1801–1809	57	Democratic Republican	Virginia	Planter
4.	James Madison	1809–1817	57	Democratic Republican	Virginia	Public official
5.	James Monroe	1817–1825	58	Democratic Republican	Virginia	Lawyer
6.	John Quincy Adams	1825–1829	57	Democratic Republican	Massachusetts	Lawyer
7.	Andrew Jackson	1829–1837	61	Democrat	Tennessee	Lawyer
8.	Martin Van Buren	1837–1841	54	Democrat	New York	Lawyer
9.	William Henry Harrison (died one month after inauguration)	1841–1841	68	Whig	Ohio	Farmer
10.	John Tyler (became president at death of Harrison)	1841–1845	51	Whig	Virginia	Lawyer
11.	James Knox Polk	1845–1849	49	Democrat	Tennessee	Lawyer
12.	*Zachary Taylor (died 16 months after inauguration)	1849–1850	64	Whig	Louisiana	Soldier
13.	Millard Fillmore (became president at death of Taylor)	1850–1853	50	Whig	New York	Lawyer
14.	Franklin Pierce	1853–1857	48	Democrat	New Hampshire	Lawyer
15.	James Buchanan	1857–1861	65	Democrat	Pennsylvania	Lawyer
16.	Abraham Lincoln (assassinated one month after second inauguration)	1861–1865	52	Republican	Illinois	Lawyer
17.	Andrew Johnson (became president at death of Lincoln)	1865–1869	56	Republican†	Tennessee	Tailor
18.	Ulysses Simpson Grant	1869–1877	46	Republican	Illinois	Soldier
19.	Rutherford Birchard Hayes	1877–1881	54	Republican	Ohio	Lawyer
20.	James Abram Garfield (died from assassin's bullet four months after inauguration)	1881–1881	49	Republican	Ohio	Lawyer
21.	Chester Alan Arthur (became president at death of Garfield)	1881–1885	50	Republican	New York	Lawyer
22.	Grover Cleveland	1885–1889	47	Democrat	New York	Lawyer
23.	Benjamin Harrison	1889–1893	55	Republican	Indiana	Lawyer
24.	Grover Cleveland (second term)	1893–1897	55	Democrat	New York	Lawyer
25.	William McKinley (died from assassin's bullet six months after second inauguration)	1897–1901	54	Republican	Ohio	Lawyer
26.	Theodore Roosevelt (became president at death of McKinley; elected president 1904)	1901–1909	42	Republican	New York	Public official
27.	William Howard Taft	1909–1913	51	Republican	Ohio	Lawyer
28.	Woodrow Wilson	1913–1921	56	Democrat	New Jersey	Educator
29.	Warren Gamaliel Harding (died 29 months after inauguration)	1921–1923	56	Republican	Ohio	Editor
30.	Calvin Coolidge (became president at death of Harding; elected president 1924)	1923–1929	51	Republican	Massachusetts	Lawyer
31.	Herbert Hoover	1929–1933	54	Republican	California	Engineer
32.	Franklin D. Roosevelt (elected four times; died three months after fourth inauguration)	1933–1945	51	Democrat	New York	Lawyer
33.	Harry S. Truman (became president at death of F. D. Roosevelt; elected president 1948)	1945–1953	60	Democrat	Missouri	Public official
34.	Dwight D. Eisenhower	1953–	62	Republican	New York	Soldier

*In 1849, March 4 fell on Sunday and Taylor did not take the oath of office until the following day. It is popularly believed, therefore, that David R. Atchison, president of the Senate, was acting president of the U.S. for a day—from noon March 4 to noon March 5, but this belief has never been supported by competent legal authority.

†Johnson had been elected vice-president on the Republican ticket, but was himself a Democrat.

ary War For membership, *see in Index* Religion *table*

Protestantism *See also in Index* Reformation Protestant, and chief denominations by name
- chief denominations R-101
- growth of C-302–3
- missionary work C-303–4
- origin of term R-92
- unity modern trend toward C-304

Protestant Union (formed 1608) T-118

Proteus (*prō'tūs* or *prō'tē-ūs*), a sea god in Greek mythology P 422

Prothal'lium, or **prothal'lus**, of ferns F-53–4, *pictures* F-53, S-356

Prothero (*proth'ēr ō*) **Sir George Walter** (1848–1922), English historian and editor born Wiltshire, England professor of history University of Edinburgh 1894–99; editor *The Quarterly Review* 1899–1922 coeditor The Cambridge Modern History

Protho'rax, the first segment of an insect's thorax
- movable in beetles B-108

Prothrombin, in blood plasma B-209

Protists (*prō'tists*) in biology L-225, *pictures* L-224*d*

Protococcus (*prō-to-kŏk'ŭs*), a single-celled plant L-224*a c, d*

'Protocols of the Elders of Zion' (first published in Russia 1905 said to be secret minutes of first Zionist Congress) a false document purporting to reveal Jewish plans to dominate the world used in Nazi anti-Semitic propaganda

Proton, electropositive particle of an atom A-457–62*b*, M 142*h*, *pictures* R 54*a*
- accelerator A-462*b*, *diagram* A-462*b*, *picture* A-462*b*
- electric charge A-460
- in atomic fission A-462, 464, *diagram* A 465
- mass *table* A-460
- neutron-proton ratio R-54*b*, *picture* R-54*c*
- size *table* A-460
- weight A-458

Protone'ma, of moss M-404, *picture* M-405

Pro'toplasm, basic material of living organisms P 422, B-151, 148, L 224–5
- chemical elements and structure B-145–6, B 148, L-224–224*a*, *c*

Protozo'a the single celled animals as a group P 423, Z-361, *picture* P-423, *Reference Outline* Z-364
- amoeba A 236*b*–7, L 224–224*a*, *pictures* A 236*b*
- classification *pictures* A-251, L-224*d*
- disease producers D 102
- paramecium P-423
- phosphorescent P-208
- sleeping sickness caused by, *picture* D 102
- termite partnership T-74

Protractor, instrument used to measure and lay out angles M-157*b*

Proudhon (*prū-dōn'*) **Pierre Joseph** (1809–65) French writer and economic theorist C-427

Proust (*prūst*) **Joseph Louis** (1754–1826) French chemist isolated a number of sugars
- law of definite proportions or definite composition C-222, 209

Proust, Marcel (1871–1922) French writer born Paris wrote subtle detailed psychological novels author of 'A la recherche du temps perdu' ('Remembrance of Things Past'), a series won Goncourt prize 1919
- French titles of chief works F 290
- influence on world literature F 289

Prout Father *See in Index* Mahony, Francis

Prout, Samuel (1783–1852), English water-color painter and lithographer, born Plymouth, known for rural and street scenes marine and architectural subjects, painted in England and on continent

Prout, William (1785–1850), English physician and worker in physiological chemistry, believed that all the elements were compounds of one "mother substance" hydrogen

Prouty, Olive Higgins (born 1882), writer born Worcester Mass, wrote 'Stella Dallas' and novels about Vale family of Boston ('White Fawn', 'Lisa Vale' 'Now, Voyager', 'Home Port' 'Fabia')

Provençal (*prō-van-sal*) old French dialect spoken in Provence R-180

Provence (*prō-vans'*) old province in s e France annexed by France 1486 *map* F-270
- language R-180
- racial character F-259

KINGS OF PRUSSIA AND GERMAN EMPERORS

1701–1713	Frederick I
1713–1740	Frederick William I
1740–1786	Frederick II, the Great
1786–1797	Frederick William II
1797–1840	Frederick William III
1840–1861	Frederick William IV
1861–1888	William I (German Emperor 1871)
1888	Frederick III
1888 1918	William II
[1918	Republic established]

Provencher, Joseph Norbert (1787–1853), Canadian Roman Catholic prelate born Nicolet Quebec, missionary in Northwest bishop of St Boniface Manitoba founded St Boniface College 1818

Proverb, a short pithy saying in common usage expressing wisdom as 'Haste maketh waste" *list* F-3
- origin in fables F 2

Proverbs, Book of, twentieth book of the Old Testament containing a collection of the sayings of the sages of Israel a large proportion ascribed to Solomon

Providence, R I state capital and chief city, pop 248 674 P-423–4, *maps* R-141, U-253, *picture* R-135
- Capitol State *picture* R-143
- founding celebrated F-57
- Roger Williams founds W-140

Providence College, at Providence, R I Roman Catholic for men, founded 1917, arts and sciences

Providence Plantations, first settlement in Rhode Island R-143

Providence River, in Rhode Island fed by Blackstone and Pawtuxet, empties into Narragansett Bay, navigable to Providence *map* R-141

Province, in ancient Rome a conquered territory governed by a Roman official in North America term generally applies to a definite territorial division of Canada

Provincetown, Mass town at tip of Cape Cod peninsula pop of township 3795 picturesque harbors, fishing boats fishermen and sand dunes attract artists *map* M-133, *picture* M-139
- *Mayflower* anchors at M-147

Provincetown Players, a theater group organized in Provincetown Mass in 1915, to "give American playwrights a chance to work out their ideas in freedom' Susan Glaspell, George Cram Cook and Eugene O'Neill were prominent in the group Moved to New York City in 1916 and continued until 1929
- Edna St Vincent Millay and M 255

Province Wellesley, Malay Peninsula *See in Index* Penang Island

Provitamins V-494

Pro'vo, Utah, city on Provo River 37 mi s e of Salt Lake City, pop 28,937, steel mills cast-iron pipe steel tanks clothing canned goods Brigham Young University Provo Canyon Bridal Veil Falls Utah Lake, and Timpanogos Cave National Monument attract tourists *maps* U-416, U-252
- Geneva Steel Mill, *picture* U-418

Provost, Etienne (1782?–1850) French Canadian fur trader with Ashley's expeditions to Rocky Mountain regions (1822–26) guide for Audubon (1843) City river valley in Utah city in South Dakota named Provo for him U-409

Prox'ima Centaur'i, a star S 371

Proximity fuse, in artillery R-28, A-397, *pictures* A-398, H-376

Proxy, authorization for voting S-398*a*

Prudence and Melibeus, in Chaucer's 'Canterbury Tales C-203

Prudhomme, Sully-. *See in Index* Sully-Prudhomme

Prud'hon (*prū-dōn'*) **Pierre** (1758–1823), French painter born Cluny France, renowned chiefly for his paintings of classical subjects ('Psyche Carried off by Zephyrus 'Andromache Embracing Astyanax')
- portrait of Empress Josephine, *picture* J-364

Prune P-424, *picture* P-424

Prunel'la (from French *prunelle* "plum," because of its original color), a stout smooth-finished worsted cloth used for dresses and scholastic and ecclesiastic gowns formerly for uppers of shoes

Pruning, of fruit trees and vines F-306, G-156, *picture* F 304

Pru'nus, a genus of fruit trees C-223*a*

Prus'sia, former German state before World War II its area was 114 527 sq mi and its population 41 915-000, large area included in Poland since 1945 P-424–424*a* *map* P-424*a* For a list of the kings of Prussia *see table* on this page
- capital Berlin B-126–30, *pictures* B-126–9
- history P-424–424*a*, G-97, *Reference-Outline* G-103
  - Teutonic Knights help found C-523
  - Hohenzollern line H-406
  - Frederick the Great F-282
  - Silesia seized A-497, M 95
  - partition of Poland P-344
  - Seven Years' War S 107–8
  - hostility toward French Revolution F 293
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  - Revolution of 1848 P-424*a*
  - Bismarck B-197–8
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  - Franco-Prussian War F-277–8 *See also in Index* Franco-Prussian War
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